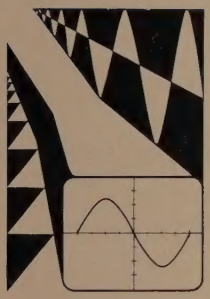
PHILIPS



10 MHz Dual-beam storage oscilloscope

PM 3234

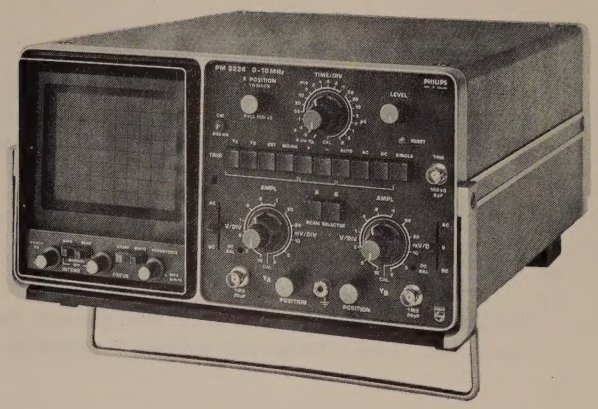
(9444 032 34...)

41728-1

9499 440 14502 750615/01/02/03

PHILIPS

PHILIPS



Instruction manual
Anleitung
Notice d'emploi et d'entretien

10 MHz DUAL - BEAM STORAGE OSCILLOSCOPE
10 MHz ZWEISTRAHL - SPEICHEROSZILLOGRAF
10 MHz OSCILLOSCOPE DOUBLE TRACE A MEMOIRE

PM3234

(9444 032 34...)

PHILIPS

ordering number
of this manual: 9499 440 14502

750615/01/02/03

IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate at the bottom of the instrument.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Unterseite des Geräts.

IMPORTANT

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques fixée sur la plaque de fond de l'appareil.

© N.V. PHILIPS' GLOEILAMPENFABRIEKEN - EINDHOVEN - THE NETHERLANDS - 1975

PRINTED IN THE NETHERLANDS

Table of contents

English

1.	**GENERAL INFORMATION**	13
1.1.	Introduction	13
1.2.	Characteristics	14
1.3.	Accessories	17
2.	**DIRECTIONS FOR USE**	18
2.1.	Installation	18
2.1.1.	Removing and fitting the front cover	18
2.1.2.	Adjusting to the local mains supply and fuses	18
2.1.3.	Supply from an external d.c. source	19
2.1.4.	Earthing	19
2.1.5.	Switching on	19
2.1.6.	From the cold into the warmth	19
2.2.	Operating instructions	21
2.2.1.	Controls and sockets	21
2.2.2.	Preliminary settings	23
2.2.2.1.	Use as an ordinary oscilloscope	23
2.2.2.2.	Use as a storage oscilloscope	23
2.2.3.	Inputs Y_A and Y_B and their possibilities	24
2.2.3.1.	YT Measurements	24
2.2.3.2.	XY Measurements	24
2.2.3.3.	Influence of the AC-0-DC switch	24
2.2.4.	Triggering	24
2.2.4.1.	General	24
2.2.4.2.	Trigger coupling	24
2.2.4.3.	Trigger level	25
2.2.4.4.	Automatic triggering	25
2.2.4.5.	External triggering	25
2.2.4.6.	Triggering with the mains frequency	25
2.2.4.7.	Position SINGLE and use of the RESET push-button	25
2.2.5.	Time-base magnifier	25
2.2.6.	The dual-beam storage tube	26
2.2.6.1.	Storage principle	26
2.2.6.2.	Construction and operation of the storage C.R.T.	26
2.3.	Description of the block diagram	28
2.4.	Brief checking procedure	29
3.	**SERVICE DATA**	71

List of figures

Fig. 1.1.	Dual-beam storage oscilloscope PM 3234	13
Fig. 2.1.	Rear view showing sockets	18
Fig. 2.2.	Rear view showing fuse VL802	19
Fig. 2.3.	Front view showing controls and sockets	20
Fig. 2.4.	Secondary emission ratio	26
Fig. 2.5.	Simplified CRT construction	27
Fig. 2.6.	Mesh construction used for collector and storage grids	27
Fig. 2.7.	Detail of storage system construction	27
Fig. 2.8.	Storage system at full brightness	27
Fig. 2.9.	Storage system at cut-off	27
Fig. 2.10.	Block diagram	28
Fig. 3.1.	Vertical amplifier, channel Y_A	71
Fig. 3.2.	Block diagram of the drift-reduction circuit	72
Fig. 3.3.	Trigger unit	74
Fig. 3 4.	Time-base generator	76
Fig. 3.5.	Horizontal amplifier	77
Fig. 3.6.	Cathode-ray tube circuitry	78
Fig. 3.7.	Effect of the focus control	79
Fig. 3.8.	Potential on g2'-g2'' during storage mode	80
Fig. 3.9.	Potential on g9 during erase cycle	81
Fig. 3.10.	Potential on g9 during variable presistence mode	82
Fig. 3.11.	Operational amplifier	83
Fig. 3.12.	Simplified circuit diagram of ABC stage and storage unit	85
Fig. 3.13.	Power supply	86
Fig. 3.14.	Basic diagram of the converter	86
Fig. 3.15.	Adjusting and dismantling	88
Fig. 3.16.	Adjusting and dismantling	99
Fig. 3.17.	Adjusting	99
Fig. 3.18.	Adjusting and dismantling	99
Fig. 3.19.	Adjusting	99
Fig. 3.20.	Knobs	101
Fig. 3.21.	Dismantling	103
Fig. 3.22.	Dismantling	103
Fig. 3.23.	Dismantling	104
Fig. 3.24.	Dismantling	105
Fig. 3.25.	Supply unit swiveled out	105
Fig. 3.26.	Replacing a push-button switch	106
Fig. 3.27.	Front cover	108
Fig. 3.28.	Adapter MP9051	108
Fig. 3.29.	Attenuator probe set PM 9326 (PM 9327)	109
Fig. 3.30.	Adjusting and attenuator probe	110
Fig. 3.31.	Attenuator probe set PM 9336 (PM 9336L)	111
Fig. 3.32.	Probe compensating	112
Fig. 3.33.	Probe set PM 9335	113
Fig. 3.34.	Attenuator probe set PM 9358	115
Fig. 3.35.	Probe compensation	116
Fig. 3.36.	Adapter set PM 9333	117
Fig. 3.37.	Multi-purpose camera PM 9380	117
Fig. 3.38.	Adapter PM 9379	118
Fig. 3.39.	Front view showing item numbers	121
Fig. 3.40.	Top and rear view showing item numbers	121
Fig. 3.41.	Bottom view showing item numbers	121
Fig. 3.42.	Front cover showing item numbers	121
Fig. 3.43.	Lay-out of the AMPL and TIME/div switches	122

Fig. 3.44.	Delay line unit	134
Fig. 3.45.	Automatic brightness control unit	134
Fig. 3.46.	C.R.T. adjustment unit	134
Fig. 3.47.	A and B vertical amplifier unit	134
Fig. 3.48.	Storage unit	134
Fig. 3.49.	Time-base unit	134
Fig. 3.50.	Power supply unit	134
Fig. 3.51.	Circuit diagram of the complete oscilloscope PM 3234	135

Inhaltsverzeichnis

Deutsch

1.	**ALLGEMEINE INFORMATIONEN**	31
1.1.	Einleitung	31
1.2.	Technische Daten	32
1.3.	Zubehör	35
2.	**GEBRAUCHSANLEITUNG**	36
2.1.	Inbetriebnahme	36
2.1.1.	Abnehmen und Aufsetzen des Deckels	36
2.1.2.	Netzspannungseinstellung und Sicherungen	36
2.1.3.	Anschluss an eine externe Gleichspannungsquelle	37
2.1.4.	Erdung	37
2.1.5.	Einschalten	37
2.1.6.	Inbetriebnahme eines unterkühlten Gerätes	37
2.2.	Bedienungsanleitungen	39
2.2.1.	Bedienungsorgane und Buchsen	39
2.2.2.	Grundeinstellungen	41
2.2.2.1.	Verwendung als gewöhnlichen Oszillograf	41
2.2.2.2.	Verwendung als Speicheroszillograf	41
2.2.3.	Eingänge Y_A und Y_B und ihre Möglichkeiten	42
2.2.3.1.	Y-T-Messungen	42
2.2.3.2.	X-Y-Messungen	42
2.2.3.3.	Funktion des Schalters AC-0-DC	42
2.2.4.	Triggerung	42
2.2.4.1.	Allgemeines	42
2.2.4.2.	Triggerkopplung	43
2.2.4.3.	Triggerpegel	43
2.2.4.4.	Automatische Triggerung	43
2.2.4.5.	Externe Triggerung	43
2.2.4.6.	Triggerung mit Netzfrequenz	43
2.2.4.7.	Stellung SINGLE und Verwendung des Knopfes RESET	43
2.2.5.	Dehnung der Zeitablenkung	43
2.2.6.	Die Zweistrahl-Speicherröhre	44
2.2.6.1.	Speicher Prinzip	44
2.2.6.2.	Konstruktion und Betrieb der Speicher-Elektronestrahlröhre	44
2.3.	Beschreibung des Blockschaltbildes	46
2.4.	Kurze Prüfanleitung	47
3.	**SERVICEANLEITUNG (nur auf english)**	71

Bildverzeichnis

Abb. 1.1. Zweistrahl-Speicheroszillograf PM 3234 31
Abb. 2.1. Rückansicht mit Buchsen 36
Abb. 2.2. Rückansicht mit Sicherung VL 802 37
Abb. 2.3. Vorderansicht mit Bedienungsorganen und Buchsen 38
Abb. 2.4. Sekundäremissionsverhältnis-Kurve 44
Abb. 2.5. Vereinfachtes Schaltbild der Elektronenstrahlröhre 45
Abb. 2.6. Ausschnitt aus den Speicher- und Kollektornetzen 45
Abb. 2.7. Querschnitt des Speichersystems 45
Abb. 2.8. Speichersystem mit hohem Helligkeitsgrad 45
Abb. 2.9. "Cut off" des Speichersystems 45
Abb. 2.10. Blockschaltbild der Driftkompensation 28
Abb. 3.1. Y-Verstärker, Kanal YA 71
Abb. 3.2. Blockschaltbild der Driftkompensation 72
Abb. 3.3. Triggereinheit 74
Abb. 3.4. Zeitablenkgenerator 76
Abb. 3.5. X-Verstärker 77
Abb. 3.6. Schaltung der Elektronenstrahlröhre 78
Abb. 3.7. Effekt der Fokussierung 79
Abb. 3.8. Potential an g2'-g2'' während des Speicherbetriebs 80
Abb. 3.9. Potential an g9 während Löschzyklus 81
Abb. 3.10. Potential an g9 während Betriebsart variable "persistence" 82
Abb. 3.11. Operationeller Verstärker 83
Abb. 3.12. Vereinfachtes Schaltbild der ABC- und Speicherstufe 85
Abb. 3.13. Netzteil 86
Abb. 3.14. Prinzipeschaltung des Spannungswandlers 86
Abb. 3.15. Einstellungen und Ausbau 88
Abb. 3.16. Einstellungen und Ausbau 99
Abb. 3.17. Einstellungen 99
Abb. 3.18. Einstellungen und Ausbau 99
Abb. 3.19. Einstellungen 99
Abb. 3.20. Knöpfe 101
Abb. 3.21. Ausbau 103
Abb. 3.22. Ausbau 103
Abb. 3.23. Ausbau 104
Abb. 3.24. Ausbau 105
Abb. 3.25. Stromversorgungseinheit herausgeklappt 105
Abb. 3.26. Ersatz eines Tastenschalters 106
Abb. 3.27. Frontdeckel 108
Abb. 3.28. Adapter PM 9051 108
Abb. 3.29. Spannungsteiler - Messkopfsätze PM 9326 und PM 9327 109
Abb. 3.30. Abgleich des Spannungsteiler - Messkopfes 110
Abb. 3.31. Spannungsteiler - Messkopfsätze PM 9336 und PM 9336 L 111
Abb. 3.32. Abgleich des Spannungsteiler - Messkopfes 112
Abb. 3.33. Messkopfsatz PM 9335 113
Abb. 3.34. Spannungsteiler - Messkopfsatz PM 9358 115
Abb. 3.35. Abgleich des Spannungsteiler - Messkopfes 116
Abb. 3.36. Messklemmensatz PM 9333 117
Abb. 3.37. Mehrzweck-Registrierkamera PM 9380 117
Abb. 3.38. Adapter PM 9379 118
Abb. 3.39. Frontansicht mit Angabe der Ersatzteile 121
Abb. 3.40. Rück- und Obenansicht mit Angabe der Ersatzteile 121
Abb. 3.41. Ansicht von unten mit Angabe der Ersatzteile 121
Abb. 3.42. Frontdeckel mit Angabe der Ersatzteile 121

Abb. 3.43. Schalterebenen für Schalter AMPL und TIME/div 122
Abb. 3.44. Printplatte Verzögerungseinheit 134
Abb. 3.45. Printplatte der automatischen Helligkeitssteuerung 134
Abb. 3.46. Printplatte für Einstellung der Elektronenstrahlröhre 134
Abb. 3.47. Printplatte der Y-Verstärker 134
Abb. 3.48. Printplatte Speichereinheit 134
Abb. 3.49. Printplatte Zeitbasiseinheit 134
Abb. 3.50. Printplatte Versorgungsteil 134
Abb. 3.51. Gesamtschaltbild PM 3234 135

Table des matières

Français

1.	**GENERALITES**	49
1.1.	Introduction	49
1.2.	Caractéristiques techniques	50
1.3.	Accessoires	53
2.	**MODE D'EMPLOI**	54
2.1.	Installation	54
2.1.1.	Dépose et repose du couvercle frontal	54
2.1.2.	Adaptation au secteur et fusibles	54
2.1.3.	Alimentation par une source continue externe	55
2.1.4.	Mise à la terre	55
2.1.5.	Enclenchement	55
2.1.6.	Passage d'un endroit froid dans un endroit chaud	55
2.2.	Manipulation	57
2.2.1.	Commandes et douilles	57
2.2.2.	Réglages préliminaires	59
2.2.2.1.	Utilisation normale	59
2.2.2.2.	Utilisation mémoire	59
2.2.3.	Entrées Y_A et Y_B et leurs possibilités	60
2.2.3.1.	Mesures YT	60
2.2.3.2.	Mesures XY	60
2.2.3.3.	Influence du commutateur AC-0-DC	60
2.2.4.	Déclenchement	60
2.2.4.1.	Généralités	60
2.2.4.2.	Accouplement de déclenchement	60
2.2.4.3.	Niveau de déclenchement	61
2.2.4.4.	Déclenchement automatique	61
2.2.4.5.	Déclenchement externe	61
2.2.4.6.	Déclenchement avec fréquence secteur	61
2.2.4.7.	Position SINGLE et utilisation du bouton-poussoir RESET	61
2.2.5.	Agrandisseur de la base de temps	62
2.2.6.	Tube-mémoire double faiseau	62
2.2.6.1.	Principe de stockage	62
2.2.6.2.	Construction et fonctionnement du T.R.C.	62
2.3.	Description du schéma synoptique	64
2.4.	Bref processus de contrôle	65
3.	**DOCUMENTATION DE SERVICE (seulement en anglais)**	71

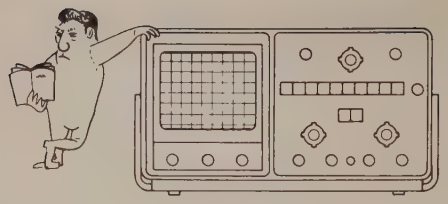
Figures

Fig. 1.1.	Oscilloscope double trace à mémoire PM 3234	49
Fig. 2.1.	Vue arrière montrant les douilles	54
Fig. 2.2.	Vue arrière montrant le fusible VL 802	55
Fig. 2.3.	Vue frontale montrant les commendes et douilles	56
Fig. 2.4.	Courbe du rapport d'émission secondaire	62
Fig. 2.5.	Synoptique simplifié du tube cathodique à mémoire	63
Fig. 2.6.	Détail des grilles de stockage et collecteur	63
Fig. 2.7.	Détail du système de mémorisation	63
Fig. 2.8.	Système de stockage à grande brillance	63
Fig. 2.9.	Système de stockage au "cut-off"	63
Fig. 2.10.	Schéma synoptique	28
Fig. 3.1.	Amplificateur vertical, voie YA	71
Fig. 3.2.	Schéma synoptique du circuit réduction de dérive	72
Fig. 3.3.	Unité de déclenchement	74
Fig. 3.4.	Générateur de base de temps	76
Fig. 3.5.	Amplificateur horizontal	77
Fig. 3.6.	Circuits du tube à rayons cathodiques	78
Fig. 3.7.	Effet de la commande du foyer	79
Fig. 3.8.	Potentiel des grilles g2'-g2" pendant le stockage de l'information	80
Fig. 3.9.	Potentiel de la grille g9 pendant un cycle d'effacement	81
Fig. 3.10.	Potentiel de la grille g9 pendant le mode "persistance variable"	82
Fig. 3.11.	Amplificateur opérationnel	83
Fig. 3.12.	Synoptique simplifié de l'étage ABC et de mémoire	85
Fig. 3.13.	Alimentation	86
Fig. 3.14.	Schéma de base du convertisseur	86
Fig. 3.15.	Réglage et démontage	88
Fig. 3.16.	Réglage et démontage	99
Fig. 3.17.	Réglage	99
Fig. 3.18.	Réglage et démontage	99
Fig. 3.19.	Réglage	99
Fig. 3.20.	Boutons	101
Fig. 3.21.	Démontage	103
Fig. 3.22.	Démontage	103
Fig. 3.23.	Démontage	104
Fig. 3.24.	Démontage	105
Fig. 3.25.	Unité d'alimentation pivotée vers l'extérieur	105
Fig. 3.26.	Remplacement d'un commutateur bouton-poussoir	106
Fig. 3.27.	Couvercle frontal	108
Fig. 3.28.	Adaptateur PM 9051	108
Fig. 3.29.	Jeu de sonde atténuatrice PM 9326 (PM 9327)	109
Fig. 3.30.	Réglage d'une sonde atténuatrice	110
Fig. 3.31.	Jeu de sonde atténuatrice PM 9336 (PM 9336L)	111
Fig. 3.32.	Réglage d'une sonde atténuatrice	112
Fig. 3.33.	Jeu de sonde PM 9335	113
Fig. 3.34.	Jeu de sonde atténuatrice PM 9358	115
Fig. 3.35.	Réglage d'une sonde atténuatrice	116
Fig. 3.36.	Adaptateur PM 9333	117
Fig. 3.37.	Appareil de photographie d'oscillogrammes	117
Fig. 3.38.	Adaptateur PM 9379	118
Fig. 3.39.	Vue avant avec numéros de repère	121
Fig. 3.40.	Vue du dessus et arrière avec numéros de repère	121
Fig. 3.41.	Vue du dessous avec numéros de repère	121
Fig. 3.42.	Couvercle frontal avec numéros de repère	121
Fig. 3.43.	Vue d'ensemble des commutateurs AMPL et TIME/div	122

Fig. 3.44. Platine imprimée de l'unité de ligne à retard 134
Fig. 3.45. Platine de commande automatique de brillance 134
Fig. 3.46. Platine pour réglage TRC 134
Fig. 3.47. Platine imprimée des amplificateurs verticaux 134
Fig. 3.48. Platine mémoire 134
Fig. 3.49. Platine imprimée du générateur de base de temps 134
Fig. 3.50. Platine imprimée de l'unité d'alimentation 134
Fig. 3.51. Schéma du circuit complet PM 3234 135

Operating manual

1. GENERAL INFORMATION



1.1. Introduction

The 10 MHz Dual-beam storage Oscilloscope PM 3234 has been designed for general laboratory, service and educational applications.
Both vertical amplifiers are equipped with a drift-reduction circuit, a delay line and a fully protected field-effect transistor input. All circuits are entirely transistorized and the transistors have been mounted on supports to enable quick servicing.
The instrument can be supplied from either a.c. mains or external d.c. sources.
Waveform are stored in the PM 3234 by using a conventional electron gun assembly to form a charge pattern on the surface of a storage layer. This pattern can be maintained for a considerable period of time, even when the apparatus has been switched off.
The length of time that a stored image remains displayed depends upon the degree of display brightness used, and can be longer than two hours. It is possible to store several single shot waveforms in order to display them simultaneously.
An erase facility enables stored information to be cancelled immediately at will.

The PM 3234 also incorporates a feature which enables display persistence to be varied over a wide range. This enables a stable display of repetitive slow-speed signals without flicker effects. The variable persistence feature also enables fast h.f. signals to be displayed. In this case, several cycles are used to develop the image on the memory layer so that a clear display can be obtained. Such displays may be obtained using signals with repetition rates as low as one cycle per minute. Single shot signals which are normally too fast for display by a conventional oscilloscope may be written by means of a 'max. write' facility. Because of the high degree of sensitivity involved in this mode of operation, display quality is slightly degraded.

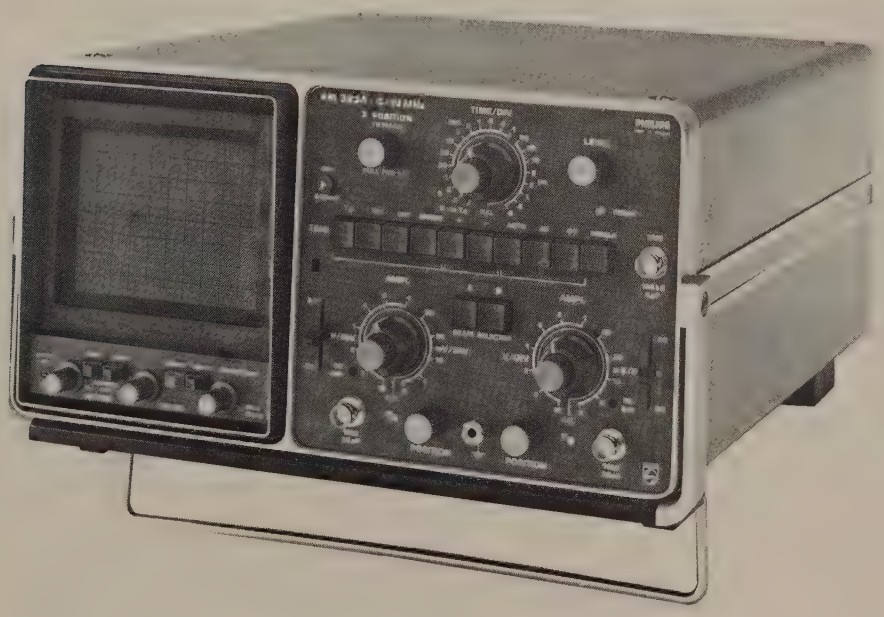


Fig. 1.1. Dual-beam storage oscilloscope PM 3234

1.2. Characteristics

Properties expressed in numerical values with stated tolerance are guaranteed for nominal mains voltages. Numerical values without tolerances are typical values representing the characteristics of an average instrument.

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.1. C.R.T.		
Type	PHILIPS L14-130GH	Split-beam tube, mesh type, post-accelerator, metal-backed phosphor, half-tone storage
Measuring area	8x10 divisions	1 div. equalling 0,9 cm
Screen type	P31 (GH) phosphor	
Total acceleration voltage	8,5 kV	
Overlap of the two systems	100 %	Both in horizontal and vertical direction
Graticule	Internal	
Engravings	8x10 divisions with sub-divisions along the central axes. Dots indicate 10 % and 90 % of measuring lattice.	
Persistence	In MEMORY OFF mode medium short	Natural persistence of P31 phosphor
	In WRITE mode from $< 0,3$ s to $\geqslant 1,5$ min	Continuously variable
Storage time	In READ mode $\geqslant 3$ min In SAVE mode $\geqslant 15$ min	
Writing speed	$\geqslant 100$ div/ms $\geqslant 1$ div/μs	In MEMORY OFF mode In MAX. WRITE mode
Erasure	approx. 600 ms	Push-button operated
1.2.2. VERTICAL AMPLIFIERS		
1.2.2.1. Response		
Frequency range	d.c. ... 10 MHz 2 Hz ... 10 MHz	-3 dB bandwidth d.c. coupled -3 dB bandwidth a.c. coupled
Rise time	35 ns	
Overshoot	2 % at maximum	Test pulse of 10 ns rise time for 6 div deflection at 1 MHz
1.2.2.2. Deflection coefficients	2 mV/div. ... 10 V/div.	Twelve calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : $\geqslant 2,5$
1.2.2.3. Error limit	$\pm$ 3 % $\pm$ 5 %	In range +5 °C ... +40 °C In range -10 °C ... +55 °C
1.2.2.4. Maximum permissible input voltage	$\pm$ 400 V	d.c. + a.c. peak

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.2.5. Instability of the spot position		
Long-term drift = short-term drift	0,25 div/hour	Typical value
1.2.2.6. Vertical positioning	16 div	
1.2.2.7. Dynamic range	24 div	Peak-to-peak amplitude for sine-wave signals; up to 3 MHz negligible distortion
1.2.2.8. Input impedance	1 MOhm/20 pF	
1.2.2.9. Input RC time	0,1 s	Coupling switch to A.C.
1.2.2.10. Visible signal display	$\geqslant$ 40 nsec	Difference between the channels 0,1 division
1.2.3. X-Y MODE	X via Y_A	x5 magnifier inoperative
Horizontal frequency range	d.c. ... 1 MHz 2 HZ ... 1 MHz	
Phase shift	5^o 1^o	At 100 kHz At 10 kHz
Additional error for Y_A channel	± 2 % ± 3 %	In range +5 °C ... +40 °C In range −10 °C ... +55 °C
1.2.4. TIME BASE		
1.2.4.1. Time coefficients	0,5 s/div ... 0,2 μs/div	Twenty calibrated positions in 1-2-5 sequence Uncalibrated continuous control 1 : $\geqslant$ 2,5
1.2.4.2. Coefficient error	± 5 %	In range −10 °C ... +55 °C
1.2.4.3. Expansion		
Magnification	5x	Switched, calibrated
Additional error	± 2 % ± 3 %	In range +5 °C ... +40 °C In range −10 °C ... +55 °C
1.2.4.4. Time-base output signal		
Output voltage	300 mV	With 50 Ohm termination
Emf (open output voltage)	6 $V_{p\text{-}p}$ (−2 V to +4 V)	The output terminal may be short-circuited without affecting the time coefficients
Internal resistance	1 kOhm	
1.2.4.5. Positioning range	The beginning and the end of the time-base line can be made visible	

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.5. TRIGGERING		
1.2.5.1. Source	Internal: channel Y_A, channel Y_B or mains freq. External	
1.2.5.2. Trigger sensitivity	Internal $\leqslant$ 1 div at 10 MHz External $\leqslant$ 1 $V_{p\text{-}p}$ at 10 MHz	For sine-wave signals
1.2.5.3. Input impedance	100 kOhm//5 pF	
1.2.5.4. Maximum permissible input voltage	± 400 V	d.c. + a.c. peak
1.2.5.5. Trigger mode	Auto A.C. D.C. Single	20 Hz ... $\geqslant$ 10 MHz 10 Hz ... $\geqslant$ 10 MHz 0 Hz ... $\geqslant$ 10 MHz
1.2.5.6. Level range	Corresponding to trace height 24 div 24 V	In the automatic mode In the A.C., D.C. and single mode External
1.2.5.7. Triggering frequency range	10 Hz ... 10 MHz d.c. ... 10 MHz 20 Hz ... 10 MHz	A.C. coupling D.C. coupling A.C. coupling in the automatic mode
1.2.5.8. Triggering slope	+ or –	
1.2.6. CALIBRATION GENERATOR		
Type	Square-wave generator	
Output voltage	600 $mV_{p\text{-}p}$	
Accuracy	± 1 %	In range +5 °C ... +40 °C
Frequency	approx. 2 kHz	
1.2.7. OPERATING CONDITIONS		
1.2.7.1. Supply	a.c. or d.c.	
Nominal voltage range (on mains voltage adaptor)	a.c. 90 V ... 140 V 180 V ... 265 V d.c. 22 V ... 30 V	
Nominal frequency range	46 Hz ... 400 Hz	
1.2.7.2. Ambient temperature		
Rated range of use	+5 °C ... +40 °C	
Limit range of operation	–10 °C ... +55 °C	
Storage and transport conditions	–40 °C ... +70 °C	
1.2.7.3. Operating position	Any	

DESIGNATION	*SPECIFICATION*	*ADDITIONAL INFORMATION*
1.2.8. WARM-UP TIME	5 minutes	At constant ambient conditions (not including recovery time; see also section 2.1.6.)
1.2.9. POWER CONSUMPTION	61 VA at 220 V a.c. 30 W at 24 V d.c.	 1,25 A current drain
1.2.10. MAINS INTERFERENCE	The instrument meets the VDE Storgrad K requirement	
1.2.11. MECHANICAL DATA		
Design	Portable	
Dimensions	Depth 503 mm Width 326 mm Height 185 mm	Incl. front cover Incl. handle Incl. feet
Weight	Approx. 11,5 kg	
1.2.12. COOLING	Natural convection	
1.2.13. COMPONENT REPLACEMENTS	Normal production types, transistors plugged in	

1.3. Accessories

1.3.1. STANDARD ACCESSORIES

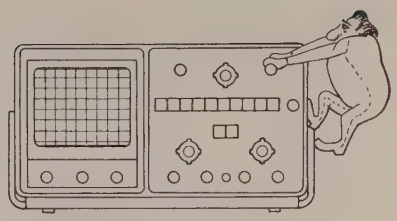
1 Front cover with storage space for two passive probes and two BNC-4 mm adapters
2 BNC-4 mm adapters PM 9051
1 Manual

1.3.2. OPTIONAL ACCESSORIES

Passive probe sets (10 : 1)	: PM 9326 and PM 9327
Passive probe sets (10 : 1)	: PM 9336 and PM 9336L
Passive probe sets (1 : 1)	: PM 9335 and PM 9335L
2 kV passive probe set (100 : 1)	: PM 9358
Probe power supply	: PM 9346
Active micro-miniature probe (10:1)	: PM 9352
Active FET probe (2 : 1)	: PM 9353
Current probe	: PM 9355
Set of miniature probe clips	: PM 9333
Multi-purpose oscilloscope camera	: PM 9380
Adapter (oscilloscope to camera)	: PM 9379
19" rackmount set	: PM 9359

See also chapter 3.5. "Information concerning accessories".

2. DIRECTIONS FOR USE



2.1. Installation

2.1.1. REMOVING AND FITTING THE FRONT COVER

Removing : – Turn the knob in the centre of the cover a quarter of a turn anti-clockwise
– Take the cover off

Fitting : – Align the key of the locking knob with the slot in the text plate of the instrument
– Fit the cover over the front of the oscilloscope
– Press the knob and turn it a quarter of a turn clockwise

WARNING

This instrument generates high voltages and should not be operated with the covers removed. The mains plug or external voltage source should be removed before attempting any maintenance work, and any relevant high voltage points dischanged.

2.1.2. ADJUSTING TO THE LOCAL MAINS SUPPLY AND FUSES

Before switching-on, the instrument must be adjusted to the local mains voltage by means of the voltage adapter at the rear of the instrument.
It is possible to adjust the instrument to 110 V, 127 V, 220 V and 240 V by means of a screwdriver.
The selected voltage is visible through the opening at the rear.
The instrument can optionaly (Spec. transformer) be adapted for 100 V, 120 V, 200 V and 220 V.
The fulse holder on the rear panel normally carries a 400 mA delayed action mains fuse but if the instrument is to be connected to a mains voltage of less then 200 V, a 800 mA fuse must be fitted.
Check that the fuse is of the specified type and current rating before connecting the oscilloscope to the mains.
The use of repaired fuses and the short-circuiting of fuse holders is prohibited.

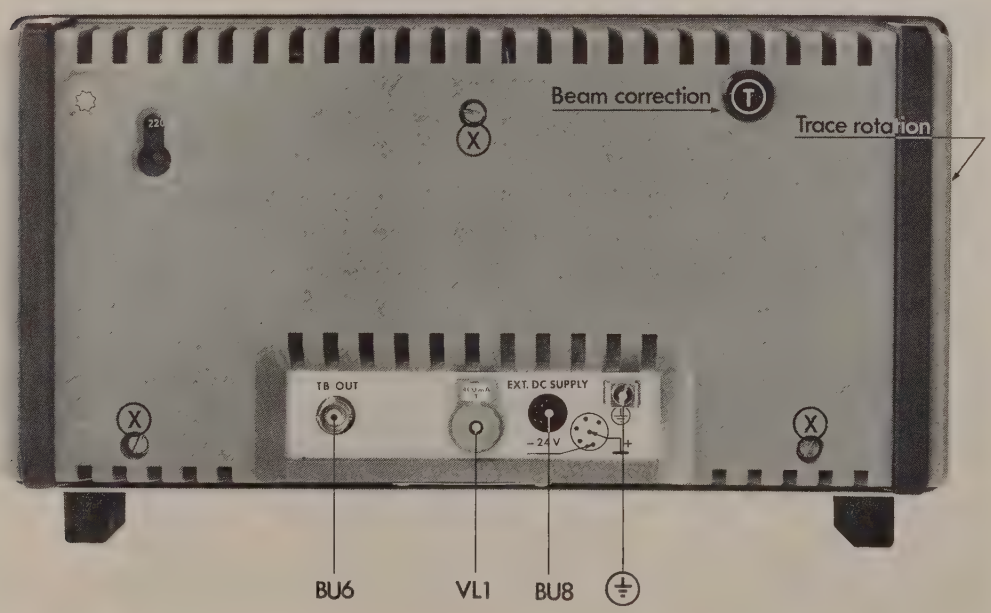


Fig. 2.1. Rear view showing sockets

2.1.3. SUPPLY FROM AN EXTERNAL D.C. SOURCE

The instrument may be supplied from an external d.c. source of 22 V to 30 V, 1,25 A. This voltage is to be applied to EXT. D.C. SUPPLY socket BU8. THE POSITIVE TERMINAL OF THE VOLTAGE SOURCE MUST BE CONNECTED TO EARTH, AS INDICATED IN THE DIAGRAM ON THE REAR TEXT PLATE, SINCE THE POSITIVE SIDE OF THE POWER SUPPLY IS CONNECTED TO CHASSIS.
The instrument is protected against reverse connection. In the case of external d.c. supply, the instrument is protected by fuse VL802 (Fig. 2.2) which is located on the power supply board and accessible after removing the rear cover. VL802 is a delayed action, 1,25 A fuse.

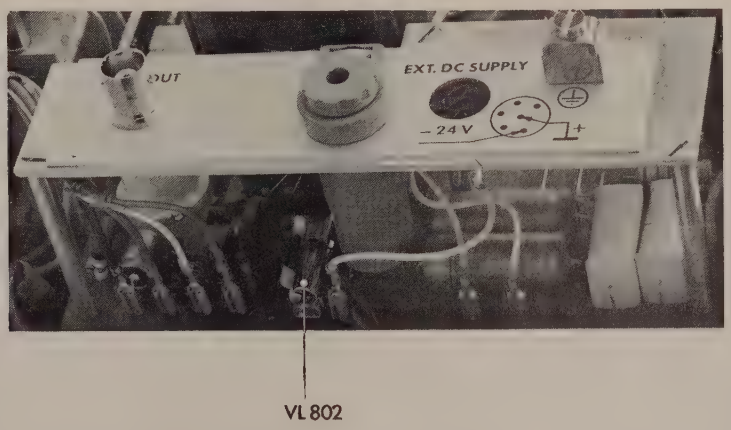


Fig. 2.2. Rear view showing fuse VL802

2.1.4. EARTHING

In the interest of safety, the oscilloscope must be connected to earth via the rear earthing terminal (identified by the symbol ⏚) or via the mains lead, provided that the supply socket is equipped with an earth connection. Care must be taken that the earth line to the oscilloscope is not interrupted due to the use of an extension lead or device which is not fitted with an earth conductor.

2.1.5. SWITCHING ON

The instrument is switched on in case of mains supply, by means of the mains switch incorporated in the INTENS control. The mains cable is located in a compartment at the bottom of the instrument.

In case of external d.c. supply, the mains switch is inoperative and the instrument is on as soon as the external source is connected. In both cases, the ON position is indicated by the white pilot lamp.

The instrument may be used in any position, but care should be taken that a free air circulation is not impeded. For temperature conditions refer to section 1.2.7.2.

2.1.6. FROM THE COLD INTO THE WARMTH

In section 1.2. Characteristics you can read that the instrument works within the specifications after a warm-up period of five minutes and at an ambient temperature between +5 °C and +40 °C.
There is, however, one exception. If you leave, for instance, your oscilloscope in your car overnight when it is freezing and then bring it into a room with a temperature of 25 °C the following morning, condensation will occur on the components.

The high-ohmic resistors in your oscilloscope then cease to be high-ohmic because of leakage currents caused by the condensation, and the oscilloscope does not work properly. In this situation, you must allow approximately 2 hours for your oscilloscope to acclimatize until all condensation has evaporated.

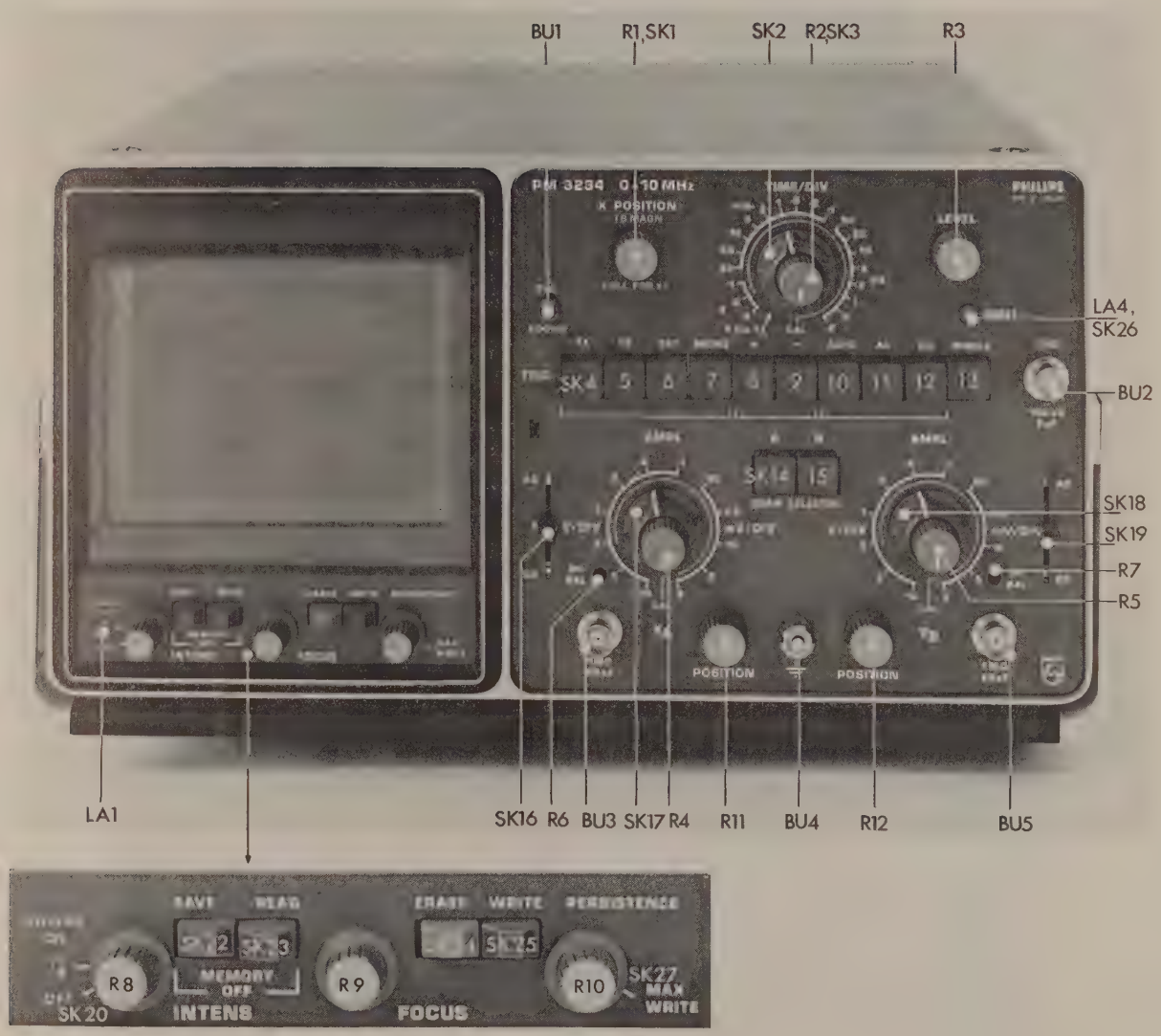


Fig. 2.3. Front view showing controls and sockets

2.2. Operating instructions

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with chapter 2.1. Installation, and that the precautions outlined have been observed.

2.2.1. CONTROLS AND SOCKETS (Fig. 2.3.)

X POSITION (R1) MAGN' (SK1)	Continuously variable control giving horizontal positioning of the display. Incorporates a switch for calibrated 5x magnification of the time base.
TIME/div (SK2)	Time-coefficient control of the time-base; 21-way switch with a position for external X deflection (X via Y_A).
CAL. - TIME/div (R2/SK3)	Continuously variable control of the time coefficients. In the CAL. position the time-coefficient is calibrated.
LEVEL (R3)	Continuously variable control to select the level at which the time-base generator starts.
CAL. (BU1)	Outlet for square-wave voltage of 600 mV_{p-p} for calibration purposes.
TRIGGERING (SK4...13)	Controls for trigger source, slope and mode; 10-way push-button switch.
Y_A (SK4)	Internal triggering signal derived from channel Y_A.
Y_B (SK5)	Internal triggering signal derived from channel Y_B.
EXT. (SK6)	Triggering signal derived from a voltage applied to the TRIGG. input socket.
MAINS (SK7)	Triggering signal derived from an internal voltage with mains frequency. This trigger source is inoperative when the instrument is supplied with an external d.c. voltage.
+ (SK8)	Provides for triggering on the positive slope of the signal.
– (SK9)	Provides for triggering on the negative slope of the signal.
AUTO (SK10)	Provides for a free-running time-base in the absence of triggering signals. and automatic signal-derived limitation on the LEVEL control range.
AC (SK11)	Triggering with coupling capacitor in triggering-signal path.
DC (SK12)	Direct coupling for triggering on a slowly varying voltage or for full-bandwidth working.
SINGLE (SK13)	If this push-button is depressed, the instrument operated in the SINGLE sweep mode.
RESET (SK26)	If switch SINGLE is in the depressed position, the time-base runs only after pressing the RESET button upon receipt of a trigger pulse.
TRIGG. (BU2)	Input BNC socket for external triggering signals.
BEAM SELECTOR A (SK14)	If this push-button is depressed, vertical deflection is achieved by the signal connected to the channel Y_A input.
BEAM SELECTOR B (SK15)	If this push-button is depressed, vertical deflection is achieved by the signal connected to the channel Y_B input. If both switch A (SK14) and switch B (SK15) are depressed, vertical deflection is achieved by both the signal connected to the channel Y_A input and the signal connected to the channel Y_B input.
AC-0-DC (SK16 & 19)	Signal coupling, three position switch. AC : via coupling capacitor O : interruption of connection between input socket and input circuit, the latter being earthed. DC : Direct coupling.

AMPL. (SK17 & 18)	Control of the vertical deflection coefficients, 12-way switch.
CAL. - AMPL. (R4 & 5)	Continuously variable control of the vertical deflection coefficients. In the CAL. position, the deflection coefficient is calibrated.
DC BAL. (R6 & 7)	Continuously variable control of the direct-voltage balance of the vertical amplifier.
INTENS (SK20 & R8)	Continuously variable control of the trace brilliance Incorporated mains switch.
SAVE (SK22)	To store the recorded waveform for a longer viewing time (protected against accidental erasure).
READ (SK23)	To observe the recorded waveform (protected against accidental erasure).
MEMORY OFF (i.e. SAVE and READ pushed simultaneously)	Allows operation of the instrument as an ordinary oscilloscope.
FOCUS (R9)	Continuously variable control of the electron-beam focusing.
ERASE (SK24)	Erases the stored display, except in the SAVE and READ mode when ERASE is disabled.
WRITE (SK25)	To record the waveform; in this mode PERSISTENCE (R10) is operative.
PERSISTENCE (R10 & SK27)	Permits variable retention of the recorded waveform. Incorporates MAX. WRITE switch.
MAX. WRITE	To increase the writing speed by a factor of approx. 10.
1 MOhm - 20 pF (BU3 & 5)	Input BNC socket for the vertical deflection signals.
POSITION (R11 & 12)	Continuously variable control giving vertical positioning of the display.
⏚ (BU4)	Earth socket.

At the rear of the instrument (Fig. 2.1.):

TB OUT (BU6)	Sawtooth output BNC socket.
TRACE ROTATION (R813)	Adjusts trace to align with the horizontal graticule lines.
EXT. DC SUPPLY (BU8)	Input socket for d.c. supply.
SCREW T	To equalize brightness of both traces.

2.2.2. PRELIMINARY SETTINGS

We recommend to allow a warm-up time of five minutes before you start your measurements. This warm-up time does not include a recovery time when the instrument comes in from the cold (see also section 2.1.6.).

– In case of mains operation:
  Check that the mains voltage adapter indicates the local mains voltage. If necessary, set the adapter to the relevant voltage in accordance with 2.1.2.
  Switch on the instrument.
– In case of external d.c. supply:
  Check that the external source is properly connected, with the positive terminal to earth.

CAUTION
EXTENDED HIGH INTENSITY MAY DAMAGE THE CRT

In the "Variable persistence" mode of operation, the CRT itself warns for too high an intensity by "blooming". When "blooming" occurs, intensity should be reduced by turning knob INTENS, R8, slightly counter-clockwise.

In the "MEMORY-OFF" and "X-Y" mode of operation, such indication does not occurs, so special care should then be taken.

2.2.2.1. Use as an ordinary oscilloscope

– The memory function of the CRT can be switched off by simultaneously pushing button SAVE, SK22, and READ, SK23. (MEMORY OFF position).
– Set FOCUS control R9 and INTENS. control R8 to their mid-positions.
– Depress BEAM SELECTOR buttons A SK14 and B SK15. Bear in mind that their will be no display if no BEAM SELECTOR button is depressed.
– Select trigger source, slope and mode. If no TRIGG. button has been depressed, the oscilloscope triggers on the Y_A signal, on the positive slope and in the AUTO mode without level range limitation.
– Display the two traces by means of Y POSITION controls R11 and R12.

The oscilloscope is then ready for use. For correction of the d.c. balance, refer to section 3.2.4.2.

2.2.2.2. Use as a storage oscilloscope

Starting from the MEMORY OFF position, when the INTENS control, R8, is adjusted for a convenient brightness of the trace and the FOCUS control, R9, is adjusted for optimum sharpness, the STORAGE mode of operation can be obtained by pushing button WRITE, SK25.

Persistence	Depending on the position of PERSISTENCE potentiometer, R10, a quickly vanishing trace will be written on a green background (R10 entirely counter-clockwise) or a slowly vanishing trace on a black background (R10 touching its first clockwise stop). The persistence can be set to suppress any flickering when displaying a low-frequency signal. For a signal with a low repetition-rate and a short rise-time, the persistence can be set so as to fill-up the trace in order to obtain a clear and steady display.
Save	If a particular trace must be retained, it can be saved by pushing button SAVE, SK22. The trace is then just visible.
Read	The intensity of the stored trace increases after pushing the READ button, SK23, but the brightness goes at the expense of storing time.
Erase	When the trace is no longer needed it can be erased by pushing button ERASE, SK24. It may happen that the trace has not entirely vanished, especially those parts which were written with a substantial brightness. This can be overcome by a prolonged actuation of the "ERASE" button.
Max. write	The writing speed can be increased by a factor of approx. 10 by putting PERSISTENCE control, R10, in its MAX. WRITE position i.e. touching its second clockwise stop, so that switch SK27 is switched over. The MAX. WRITTE mode of operation is required for short sweep times or for signals with a short rise-time.

2.2.3. INPUTS Y_A AND Y_B AND THEIR POSSIBILITIES

The PM 3234 has been provided with two identical vertical channels which can be used for either YT measurements in combination with the time-base generator, or XY measurements up to frequencies of 1 MHz, and with the possibility to store the displays in different modes.

2.2.3.1. YT Measurements

To display one signal, either of the two vertical channels can be selected by operating either BEAM SELECTOR A SK14 or BEAM SELECTOR B SK15. When both push-buttons A SK14 and B SK15 are depressed, two signals can be displayed simultaneously. The Y deflection coefficient can be individually set for each channel.

2.2.3.2. XY Measurements

If TIME/div switch SK2 is set to position X via Y_A, the time base generator is switched off.
The signal of the Y_A channel is displayed horizontally. The Y_A controls, except the POSITION potentiometer R11, then control the X deflection. Positioning of the trace in horizontal sense is still possible with X POSITION control R1. The x5 MAGNIFIER switch SK1, however, is inoperative.
In this mode, XY measurements can be up to a frequency of 100 kHz.

2.2.3.3. Influence of the AC-0-DC switch

Signals to be studied can be fed to Y_A input socket BU3 and/or Y_B input socket BU5. Depending on the composition of the signal, the AC-0-DC switch should be set to position AC or DC. In position DC, the input is coupled direct to the Y amplifier. Because the Y amplifier is d.c. coupled, the entire bandwidth of the instrument is available. This means that the complete input voltages are fed to the deflection plates, which implies that the d.c. components result in trace shifts on the screen.
This may cause difficulties when a.c. signals superimposed on high direct voltages have to be displayed.
In oder to make the a.c. signal visible in those cases, a greater attenuation will be necessary with the result that the a.c. signal will also be strongly attenuated.

In this case the AC-0-DC switch can be set to position AC. Then a blocking capacitor is connected between the input socket and the Y amplifier. As a result of this, d.c. voltages are blocked, but also the lower frequencies are suppressed or attenuated. When square-wave signals of low frequency are displayed, this will result in some pulse droop.
In the 0 position of the AC-0-DC switch it is possible to quickly determine the zero volt d.c. level.
In this position the connection between the amplifier input and the input socket is interrupted, the amplifier input being earthed. At the same time, the blocking capacitor is discharged to prevent damage of the circuit under test by a possible high charge.

2.2.4. TRIGGERING

2.2.4.1. General

In order to obtain a stationary trace, the horizontal deflection must always be started at a fixed point of the signal. The time-base generator is, therefore started by narrow trigger pulses formed in the trigger pulse shaper (Schmitt trigger), controlled by a signal originating from the vertical input signal or an external source.

2.2.4.2. Trigger coupling

AC — If the signal voltage contains a d.c. component triggering can cease when the level potentiometer cannot supply the correct d.c. level for the Schmitt trigger. In this case it is useful to apply a.c. coupling. A.C. Coupling is obtained by inserting a capacitor in the trigger path. This means that the signal can still be d.c. coupled to the Y channels.

DC — D.C. Coupling is useful when the mean value of the signal varies. This sort of signal often occurs in digital systems. With a.c. coupling the trigger point would not be fixed which would give rise to jitter or even loss of triggering.

2.2.4.3. Trigger level

In case of a complicated signal in which a number of non-identical voltage shapes occur periodically, the time axis should always be started with the same voltage shape so as to obtain a stationary trace.
This is possible when one of the details has a deviating amplitude. By means of the LEVEL knob, the trigger level can be set in such a way that only this larger voltage variation passes this level. The LEVEL control is also very useful when two signals must be accurately compared e.g. in phase measurements. By means of the LEVEL control the starting point of the traces can then be shifted exactly on to the control graticule line.

2.2.4.4. Automatic triggering

Automatic triggering, when the AUTO switch is depressed, is most often used on account of its simple operation.
In this mode it is possible to display a large variety of waveforms having different amplitude and shape, without it being necessary to operate any of the trigger controls.
If no triggering signal is present, a time-base line remains visible on the screen. This is useful for zero reference purposes. In this trigger mode the level can be adjusted over the peak-to-peak value of the a.c. components of the signal. If none of the switches AUTO, AC or DC is depressed, the oscilloscope works in the automatic mode, but with the entire level range available. This has the advantage that there is always a trace visible, even when no TRIGG. push-buttons are depressed.

2.2.4.5. External triggering

External triggering is applied for signals having a strongly varying amplitude, if a signal having a fixed amplitude and equal frequency is available. Even more important is external triggering in case of complex signals and pulse patterns. Then external triggering can be used to avoid double traces.
This obviates the necessity of readjusting the level setting at every variation of the input signal.

2.2.4.6. Triggering with the mains frequency

In this case the triggering signal is a sine-wave with the mains frequency. This trigger source is useful if the frequency of the signal under observation is coupled with the mains frequency.
It is, e.g., possible to recognize the hum component of a signal by triggering on that component.

2.2.4.7. Position SINGLE and use of the RESET push-button

When effects which occur only once have to be observed, it is often desirable to ensure that only one sweep is generated, even though several trigger pulses might be produced after the phenomenon of interst. Of course, the single sweep in question must be triggered by a trigger pulse. To this end the mode switch must be put into position SINGLE. When the RESET button has been pressed, the first following trigger pulse that appears will start the time-base generator. The trace is only written once. The time-base is then blocked until the RESET push-button is again operated.
The lamp in the RESET push-button, will light up as soon as this button is operated and will go out as soon as the sweep is initiated.

2.2.5. TIME-BASE MAGNIFIER

The magnifier is operated with a push-pull switch.
When this switch is in the x5 position, the time-base sweep speed is increased 5 times. In this position the sweep time is determined by dividing the indicated TIME/div value by 5.

2.2.6. THE DUAL-BEAM STORAGE TUBE

2.2.6.1. Storage principle

The PM 3234 oscilloscope contains a cathode-ray tube with a storage mesh with variable storage time. Therefore, the c.r.t. may be used as an ordinary one, but with a variable persistence of the displayed signal.

Information is stored by writing the signal of the main electron beam into a STORAGE LAYER of non-conductive material. As a result of the secundary emission of electrons from this layer, a positive charge pattern is formed. This charge pattern on the storage surface will remain there for a considerable length of time, also if the writing gun is switched off. The trace is displayed on the phosphor viewing screen by means of a second electron beam whose electrons can strike the phosphor via the positively charged parts on the storage layer.

Storage of information on non-conductive material is based on secundary emission. Fig. 2.4. shows the ratio between the number of electrons leaving the storage layer and the number of electrons arriving (secundary emission ratio) versus the surface potential. At a certain surface potential, V_a in Fig. 2.4. the number of electrons leaving the surface equals the number of electrons arriving. This point is called the first cross-over (secundary emission ration = 1).

If the surface of the storage layer is hit by electrons of higher energy (electrons with greater velocity), the surface will become more positive, since more electrons are leaving than arriving. If the surface is hit by electrons of lower energy (electrons with lower velocity) than at V_a, the surface potential becomes more negative, as fewer electrons are leaving than arriving.

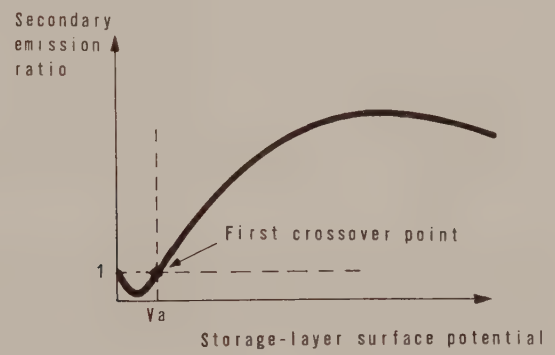


Fig. 2.4. Secondary emission ratio

2.2.6.2. Construction and operation of the storage c.r.t.

The dual-beam storage cathode-ray tube contains two systems: the WRITING system and the FLOOD system.

The dual-beam WRITING part comprises one gun in which two beams are generated that are deflected independently. This arrangement is also known as split-beam system. In this tube, both time-base lines are exactly in parallel since they originate from one point and are under the influence of one common horizontal signal amplifier. Because both traces are emitted by one gun, they show little distortion in relation to one another.

The FLOOD system consists of a pair of FLOOD GUNS operated in parallel. Both guns comprise a CATHODE k, a CONTROL GRID g1 and an ACCELERATOR GRID g2 (see Fig. 2.5.). Common to both flood guns are the FLOOD BEAM COLLIMATOR g7, the COLLECTOR MESH g8, the STORAGE MESH g9 which carries the storage layer, and the PHOSPHOR VIEWING SCREEN g10.

The flood guns are located at a point ahead of the horizontal deflection plates and the mesh. The cathode potential is approx. +30 V, this being 50 V negative in relation to the accelerator grids. Both flood gun cathodes emit a cloud of electrons. These clouds are combined by both control grids g1, accelerated by both accelerator grids g2 and shaped by the collimator g7 which consists of a coating on the inner surface of the c.r.t. bottle. The positive voltage on the collimator is such that the electron cloud emanating from the flood gun just fills the viewing area of the c.r.t.

The cloud is further accelerated in the direction of the storage mesh and the viewing screen by collector mesh g8. After passing through the collector mesh, the flood-gun electrons are controlled by the potentials on the storage mesh and storage layer surface.

A front view of the collector and storages meshes is shown in Fig. 2.6. The apertures in both meshes are approximately 40 x 40 μm. The cathode side of the storage mesh is coated with a non-conductive material on which the information is stored (see Fig. 2.7.). In other words, there exists a capacitive coupling between the storage mesh and the storage-layer surface. This capacitive coupling is essential for the proper working of the STORE and ERASE functions. The storage mesh is normally at a potential of approximately +2 V in relation to the flood-gun cathode potential, i.e. approximately +32 V with respect to earth.

The potential V_a at the storage-layer surface is controlled by WRITE and ERASE signals which are applied to the storage mesh, and varies between 2 V positive and 4 V negative in relation to the flood-gun cathode. When the storage-layer surface is at a potential of +2 V in relation to the cathode (see Fig. 2.8.), the majority of flood-gun electrons pass through the holes in the mesh and reach the phosphor screen. The remaining electrons are repelled by the storage-layer surface and collected by the collector mesh. When the potential of the storage-layer surface is negative in relation to the cathode (see Fig. 2.9.), the number of electrons passing through the storage mesh is drastically reduced or, when the cut-off level is reached, no electrons pass at all.

The post-accelerator voltage of approximately 7 kV is connected to the phosphor viewing screen. Electrons that are allowed to pass through the storage mesh are accelerated by this potential and strike the phosphor with such a velocity that a brilliant spot is obtained.

The storage-mesh may be compared to the grid of a triode. Just as the triode grid potential controls the anode current, the storage mesh controls the current of flood-gun electrons to the screen and, thus, the trace brilliance.

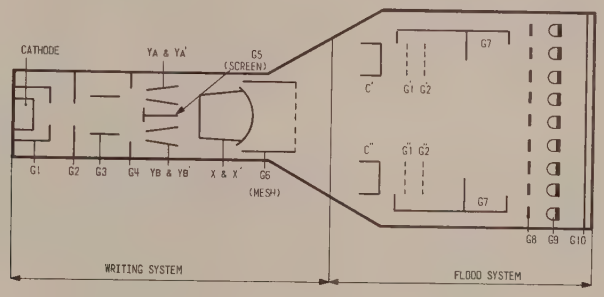


Fig. 2.5. Simplified CRT construction

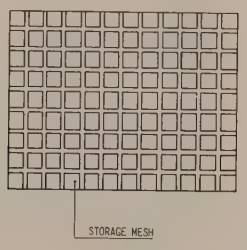


Fig. 2.6. Mesh construction used for collector

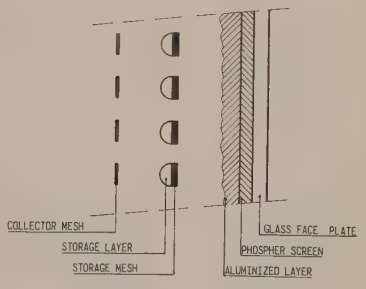


Fig. 2.7. Detail of storage system construction

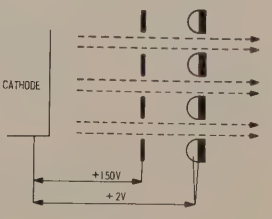


Fig. 2.8. Storage system at full brightness

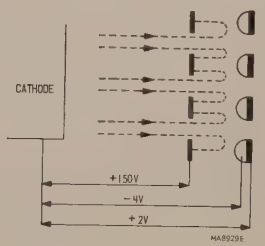


Fig. 2.9. Storage system at cut-off

2.3. Description of the block diagram

2.3.1. Y AXIS

The oscilloscope PM 3234 has two identical, d.c. coupled vertical amplifiers allowing simultaneous display of two signals. Each amplifier comprises an input step-attenuator, a source follower with protection circuitry, a pre-amplifier and a drift reduction circuit, a trigger pick-off stage, a delay line circuit and a final amplifier. Trigger pick-off stage and final amplifier (for both channels, Y_A and Y_B) have been coupled by means of the delay line circuit, which is a part of the circuitry of the delay line unit.
The protection circuitry prevents damage to the input field-effect transistors by too high sensitivity of the amplifier.

The trigger pick-off stage supplies a triggering signal to the trigger pre-amplifier in case of internal triggering, and also couples the signal to be measured to the Y final amplifier. In the Y_A channel the signal can also be coupled to the X final amplifier if the instrument is used as an XY oscilloscope. From the Y final amplifier, the signal is fed to the Y deflection plates of the c.r.t.

The delay line has been applied to enable the display of the leading edge of fast phenomena on the screen.

2.3.2. TRIGGERING

A triggering signal can be obtained from either vertical amplifier, from an external source or internally from the mains. The latter signal is not available when the instrument is supplied with an external d.c. voltage. The triggering signal is fed to a trigger pulse shaper which supplies well-defined trigger pulses to start the time-base generator. The trigger unit also comprises a single sweep circuit which causes the time-base generator to deliver one sawtooth pulse, after the RESET knob has been pressed and upon receipt of the trigger pulse. This circuit only works when switch SINGLE is depressed.

2.3.3. TIME BASE

The time-base generator is of the constant-current integrator type and supplies two output voltages.
A sawtooth voltage which is fed to the X final amplifier and an output socket at the rear of the oscilloscope and a gate pulse which controls the unblanking of the c.r.t. during the sweep.

2.3.4. X AXIS

The X final amplifier receives its input signal from either the time-base generator or from an external source via the Y_A channel. From the X amplifier the signal is fed to the horizontal deflection plates of the c.r.t. of the oscilloscope.

2.3.5. C.R.T. CIRCUITRY

The c.r.t. circuitry comprises circuits for trace blanking and unblanking, an automatic brightness control unit, circuits appertaining to the storage functions of the c.r.t. and networks for the correction of the c.r.t. characteristics

The a(utomatic) b(rightness) c(ontrol) unit ensures a virtually constant trace brilliance or a blanked trace in various display modes.

In the continuous-display mode, the trace is blanked and unblanked by a signal from the time-base generator. In the single-sweep mode, the trace is blanked via the a.b.c. unit.

The storage circuits provide the voltage levels and waveforms which are necessary for the storage operation of the c.r.t.

The correction networks comprise preset potentiometers for trace rotation, astigmatism, distortion and orthogonality correction.

The high voltages for the c.r.t. are generated by a converter which also delivers the other supply voltages.

2.4. Brief checking procedure

General: Brief checking procedure is carried out in the MEMORY OFF mode.
For all storage functions refer to chapter 3.2. (checking and adjusting).

> **CAUTION:** Use minimum beam intensity to produce a clear, well-defined display.
> Extended high intensity may damage the C.R.T.

2.4.1. STARTING POSITIONS OF THE CONTROLS

- Depress buttons SAVE SK22 and READ SK23 simultaneously.
- Push-buttons Y_A SK4, + SK8 and BEAM SELECTOR A SK14 & B SK15 depressed.
- TIME/div switch SK2 to .1 ms.
- AMPL switches SK17 & SK18 to .1 V/div.
- MAGN switch SK1 to x1.
- POSITION potentiometers R1, R11 and R12 to their mid-positions.
- Adjust INTENS potentiometer R8 for minimum display brightness.
- TIME/div and AMPL potentiometers R2, R4 and R5 to CAL.

Unless otherwise stated, the controls always occupy the same position as in the previous check.

2.4.2. C.R.T. POSITION

- Adjust FOCUS potentiometer R9 and INTENS potentiometer R8 for a well-defined display.
- Centre both time-base lines, using POSITION potentiometers R1, R11 and R12.
- Check that the time-base line runs exactly in parallel with the horizontal graticule lines.
  Correction possible with potentiometer R813 (Fig. 3.16.).
- Check the brightness equality of the two beams.
  Correction possible with screw T at the rear of the instrument (Fig. 2.1.).

2.4.3. VERTICAL CHANNELS

The check for channel Y_A is described, the relevant controls for Y_B are mentioned in brackets.

- Release BEAM SELECTOR B SK15 (A SK14).
- AC-0-DC switches SK16 & SK19 to 0.
- AMPL switch SK17 (SK18) to 2 mV/div.
- Check that the time-base line remains within 0,2 div in the centre of the screen. Correction possible with DC BAL potentiometer R6 (R7).
- AC-0-DC switch SK16 (SK19) to DC.
- Check that the time-base line has not moved more than 0,4 div. Correction possible with potentiometer R126 (R326), Fig. 3.19.
- AMPL switch SK17 (SK18) to .1 V/div.
- Apply a square-wave voltage of 600 $mV_{p\text{-}p}$ ±0,5 %, 2 kHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the trace height is 6 div ±2 %.
  Correction possible with R111 (R311), Fig. 3.18.
- Increase the frequency of the input voltage to 10 MHz.
- Check that the trace height is at least 4.2 div.

2.4.4. X VIA Y_A

- Depress BEAM SELECTOR A SK14 and B SK15.
- Set TIME/div switch SK2 to X via Y_A.
- AC-0-DC switch SK19 to 0.
- Apply a square-wave voltage of 600 mV_{p-p} ±0,5 %, 2 kHz, to Y_A input socket BU3.
- Check that the trace width is 6 div ±3 %.
  Correction possible with potentiometer R601 (Fig. 3.17.).

2.4.5. TIME-BASE

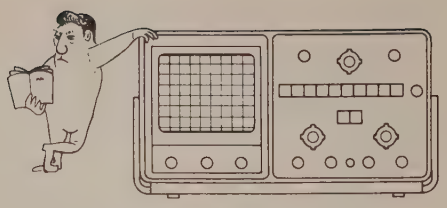
- Check the time-coefficient in position 20 μs of TIME/div switch SK2 by means of time markers.
  Tolerance ±5 %. Correction possible with potentiometer R534 (Fig. 3.17.).
- Check the other time-coefficients; tolerance ±5 %.

2.4.6. TRIGGERING

- Apply a sine-wave voltage of 100 mV_{p-p}, 10 MHz, to Y_A input BU3.
- Check that it is possible to adjust LEVEL potentiometer R3 for a stationary display.

Bedienungsanleitung

1. ALLGEMEINE INFORMATIONEN



1.1. Einleitung

Der 10-MHz-Zweistrahl-Speicher Oszillograf PM 3234 ist für allgemeine Laborarbeiten, den Service und für Unterrichtszwecke vorgesehen.
Beide Y-Verstärker besitzen eine Verzögerungsleitung und eine driftarme und voll überlastungsgeschützte Eingangsschaltung mit Feldeffekttransistoren. Alle Schaltungen sind voll transistorisiert. Die Transistoren stecken in Fassungen, damit sie nötigenfalls schnell ersetzt werden können.
Der Oszillograf kann mit Netzwechselspannung oder einer externen Gleichspannung betrieben werden.
Signalformen werden unter Anwendung einer konventionellen Elektronen Kanone, die auf der Oberfläche der Speicherschicht ein Ladungsbild formt, gespeichert.
Dieses Bild lässt sich über einen beträchtlichen Zeitraum festhalten, selbst wenn das Gerät ausgeschaltet wurde. Die Länge der Speicherzeit ist von der angewandten Darstellungshelligkeit abhängig und kann länger als zwei Stunden betragen.
Eine Löscheinrichtung ermöglicht es eine gespeicherte Information nach Belieben sofort zu annullieren.
Der PM 3234 enthält auch eine Vorrichtung womit die Nachlichtdauer der Darstellung über einen grossen Bereich variert werden kann. Dadurch wird stabile Darstellung von wiederholten Signalen niedriger Geschwindigkeit ohne Flimmern ermöglicht. Die variable Nachleuchtdauer ermöglicht auch die Darstellung schneller HF Signale. In einem solchen Fall wird die Darstellung auf der Speicherschicht in meheren Zyklen entwickelt um so eine deutliche Darstellung zu erhalten. Solche Signale erhält man durch Verwendung von Signalen von so niedriger Folgefrequenz wie ein Zyklus je Minute. Einmalige Impulse die normalerweise für Darstellung durch einen gewöhnlichen Oszillograf zu schnell sind lassen sich mit Hilfe der Betriebsart "MAX. WRITE" schreiben. Wegen der hohen Empfindlichkeit die diese Betriebsart zur Folge hat ist die Darstellungsqualität etwas geringer.

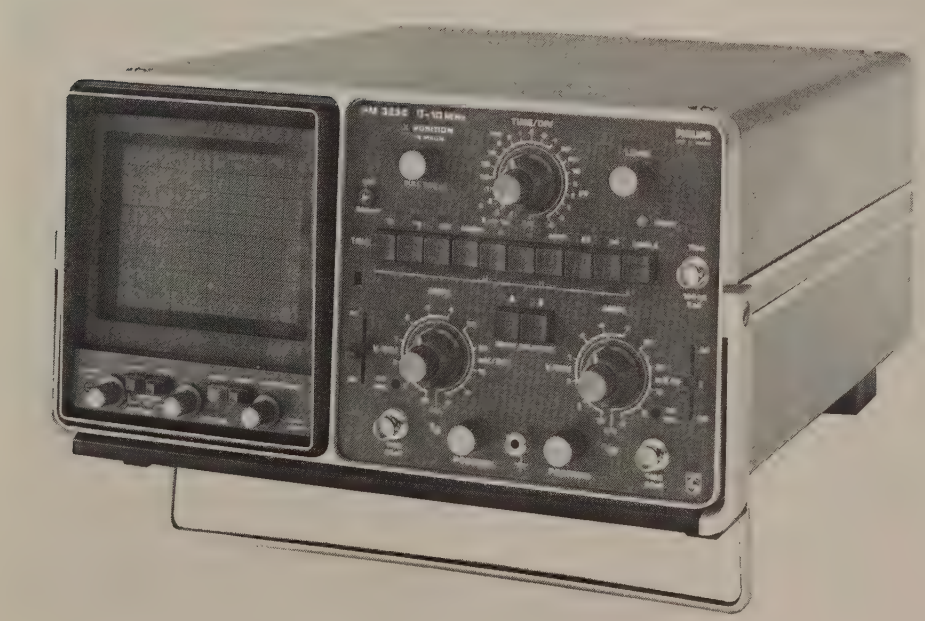


Abb. 1.1. Zweistrahl-Speicheroszillograf PM 3234

1.2. Technische Daten

Zahlenwerte mit Toleranzangabe werden bei den nominalen Netzspannungen garantiert. Zahlenwerte ohne Toleranzangabe sind Durchschnittswerte und dienen nur zur Information.

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.1. Elektronenstrahlröhre		
Type	PHILIPS L14-130GH	Spaltstrahlröhre (split-beam) mit Netz, Nachbeschleunigungselektrode und metallhinterlegtem Leuchtschirm, Halbtonspeicher.
Ausnutzbare Schirmfläche	8x 10 Div.	1 Div. beträgt 0,9 cm
Schirmtyp	Leuchtschirm P31 (GH)	
Gesamte Beschleunigungsspannung	8,5 kV	
Überlappung der beiden Systeme	100 %	Sowohl in horizontaler als auch in vertikaler Richtung
Raster	Intern	
Gravierung	8x 10 Div. mit Unterteilungen an den mittleren Achsen. Punkte bei 10 % und 90 % des Messrasters.	
Nachleuchtdauer	Bei Betriebsart MEMORY OFF medium short	Eigennachleuchtdauer von P31 Phosphor
	Bei Betriebsart WRITE von $< 0{,}3$ s bis $\geqslant 1{,}5$ min	Kontinuierlich variabel
Speicherzeit	Bei Betriebsart READ $\geqslant 3$ min Bei Betriebsart SAVE $\geqslant 15$ min	
Schreibgeschwindigkeit	$\geqslant 100$ Div./ms	Bei Betriebsart MEMORY OFF
	$\geqslant$ 1 Div./μs	Bei Betriebsart MAX. WRITE
Löschen	In etwa 600 ms	Drucktaste betätigt.
1.2.2. Y-VERSTÄRKER		
1.2.2.1. Kennlinie		
Frequenzgang	d.c. ... 10 MHz	–3 dB, Gleichspannungskopplung
	2 Hz ... 10 MHz	–3 dB, Wechselspannungskopplung
Anstiegszeit	35 ns	
Überschwingen	max. 2 %	Gemessen mit einem Testimpuls mit einer Anstiegszeit von 10 ns bei einer Ablenkung von 6 Div. und einer Frequenz von 1 MHz
1.2.2.2. Ablenkkoeffizienten	2 mV/Div. ... 10 V/Div.	Zwölf kalibrierte Stellungen, Folge 1-2-5. Dazwischen stufenlos 1 : $\geqslant 2{,}5$ einstellbar.
1.2.2.3. Fehlergrenze	$\pm$ 3 %	Im Bereich +5 °C ... +40 °C
	$\pm$ 5 %	Im Bereich –10 °C ... +55 °C

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.2.4. Maximal zulässige Eingangsspannung	±400 V	Gleichspannung + Spitzenwert einer Wechselspannung
1.2.2.5. Instabilität des Leuchtflecks		
Langzeitdrift = Kurzzeitdrift	0,25 Div.	Typischer Wert
1.2.2.6. Vertikale Strahlverschiebung	16 Div.	
1.2.2.7. Dynamischer Bereich	24 Div.	Spitze-Spitze-Wert der Amplitude von Sinusspannungen; bis 3 MHz vernachlässigbare Verzerrungen
1.2.2.8. Eingangsimpedanz	1 MΩ//20 pF	
1.2.2.9. Eingangszeitkonstante	0,1 s	Kopplungsschalter auf AC
1.2.2.10. Sichtbare Signalverzögerung	⩾ 40 ns	Unterschied zwischen den Kanälen: 0,1 Div.
1.2.3. X-Y-BETRIEB	X über Y_A	5fache Dehnung ausser Betrieb
Horizontal	d.c. ... 1 MHz	
Frequenzbereich	2 Hz ... 1 MHz	
Phasenverschiebung	5^o 1^o	Bei 100 kHz Bei 10 kHz
Zusätzlicher Fehler für Y_A-Kanal	± 2 % ± 2 %	Von +5 °C ... +40 °C Von −10 °C ... +55 °C
1.2.4. ZEITABLENKUNG		
1.2.4.1. Ablenkkoeffizient	0,5 s/Div. ... 0,2 µs/Div.	20 geeichte Stufen, Folge 1-2-5. Dazwischen stufenlos einstellbar 1 : ⩾ 2,5.
1.2.4.2. Fehler des Zeitmassstabes	±5 %	Von −10 °C ... +55 °C
1.2.4.3. Dehnung		
Faktor	5x	Geschaltet, kalibriert
Zusätzlicher Fehler	±2 % ±3 %	Von +5 °C ... +40 °C Von −10 °C ... +55 °C
1.2.4.4. Ausgangsspannung des Zeitablenkgenerators		
Ausgangsspannung	300 mV	Mit 50-Ω-Abschluss
EMF (Leerlaufspannung)	6 V_{ss} (−2 V bis +4 V)	Ein Kurzschluss dieser Buchse hat keine Rückwirkungen auf die Ablenkkoeffizienten
Innenwiderstand	1 kOhm	
1.2.4.5. Verschiebebereich	Der Anfang und das Ende der Zeitablenklinie können sichtbar gemacht werden.	

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.5. TRIGGERUNG		
1.2.5.1. Triggerquelle	Intern: Kanal Y_A, Kanal Y_B oder Netzfrequenz Extern	
1.2.5.2. Triggerempfindlichkeit	Intern $\leqslant$ 1 Div. bei 10 MHz Extern $\leqslant$ 1 V_{ss} bei 10 MHz	Für Sinusspannungen
1.2.5.3. Eingangsimpedanz	100 kΩ//5 pF	
1.2.5.4. Maximal zulässige Eingangsspannung	±400 V	Gleichspannung + Spitzenwert einer Wechselspannung
1.2.5.5. Triggerauslösung	Auto Wechselspannung Gleichspannung Einzel	20 Hz ... $\geqslant$ 10 MHz 10 Hz ... $\geqslant$ 10 MHz 0 Hz ... $\geqslant$ 10 MHz
1.2.5.6. Pegelbereich	Entsprechend der Strahlhöhe 24 Div. 24 V	Bei automatischer Triggerung Bei Wechselspannung, Gleichspannung und Einzel Triggerung Extern
1.2.5.7. Triggerfrequenzbereich	10 Hz ... 10 MHz d.c. ... 10 MHz 20 Hz ... 10 MHz	Wechselspannungskopplung Gleichspannungskopplung Wechselspannungskopplung bei automatischer Triggerung
1.2.5.8. Triggerflanke	+ oder –	
1.2.6. KALIBRIERGENERATOR		
Typ	Rechteckgenerator	
Ausgangsspannung	600 mV_{ss}	
Fehlergrenze	±1 %	Von +5 °C ... +40 °C
Frequenz	ca. 2 kHz	
1.2.7. BETRIEBSBEDINGUNGEN		
1.2.7.1. Stromversorgung	Gleich- oder Wechselstrom	
Nominaler Spannungsbereich (sichtbar auf dem Netzspannungsumschalter)	Wechselspannungen 90 V ... 140 V 180 V ... 265 V Gleichspannung 22 V ... 30 V	
Nominaler Frequenzbereich	46 bis 400 Hz	
1.2.7.2. Umgebungstemperaturen		
Die technische Daten werden eingehalten von	+5 °C ... +40 °C	
Zugelassener Betriebstemperaturbereich	–10 °C ... +55 °C	
Lagerung und Transport	–40 °C ... +70 °C	
1.2.7.3. Betriebslage	Beliebig	

BENENNUNG	*BESCHREIBUNG*	*NÄHERE ANGABEN*
1.2.8. ANWÄRMZEIT	5 min.	Bei konstanten Umgebungsbedingungen (ohne Akklimationszeits; siehe auch Abschnitt 2.1.6.).
1.2.9. LEISTUNGSAUFNAHME	61 VA bei 220 V ~ 30 W bei 24 V =	Stromaufnahme 1,25 A
1.2.10. NETZ-STÖRGRAD	Das Gerät erfüllt die Anforderungen nach VDE Störgrad K	
1.2.11. MECHANISCHE DATEN		
Ausführung	Transportabel	
Abmessungen	Tiefe 503 mm	Einschliesslich Frontdeckel
	Breite 326 mm	Einschliesslich Handgriffe
	Höhe 185 mm	Einschliesslich Füsse
Gewicht	ca. 11,5 kg	
1.2.12. KÜHLUNG	Natürliche Luftzirkulation	
1.2.13. ERSATZ VON BAUELEMENTEN	Normale Serientypen, Transistoren steckbar	

1.3. Zubehör

1.3.1. STANDARDZUBEHÖR

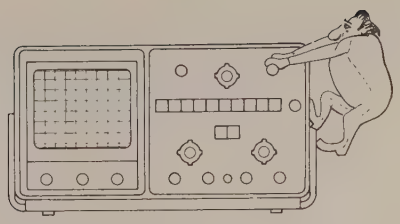
1 Frontdeckel mit Aufbewahrungsraum für zwei Spannungsteiler-Messköpfe und zwei Adapter BNC – 4 mm
2 Adapter BNC – 4 mm PM 9051
1 Anleitung

1.3.2. WAHLZUBEHÖR

Spannungsteiler-Messköpfe (10 : 1)	: PM 9326 oder PM 9327
Spannungsteiler-Messköpfe (10 : 1)	: PM 9336 oder PM 9336L
Messkopf (1 : 1)	: PM 9335 oder PM 9335L
2 kV Spannungsteiler-Messkopf (10 : 1)	: PM 9358
Messkopfspeisung	: PM 9346
Aktiver Mikro-Miniaturmesskopf (10 : 1)	: PM 9352
Aktiver FET-Messkopf (2 : 1)	: PM 9353
Strom-Messkopf	: PM 9355
Satz Miniaturmesskopfpinzetten	: PM 9333
Mehrzweck-Registrierkamera	: PM 9380
Adapter (Oszillograf/Kamera)	: PM 9379
19" Gestelleinbau-Satz	: PM 9359

Siehe auch Abschn. 3.5. "Information concerning accessories".

2. GEBRAUCHSANLEITUNG



2.1. Inbetriebnahme

2.1.1. ABNEHMEN UND AUFSETZEN DES DECKELS

Abnehmen : – Den Knopf in der Mitte des Deckels eine viertel Umdrehung nach links drehen.
– Den Deckel abnehmen.

Aufsetzen : – Den Verriegelungsstift so ausrichten, dass er in den Schlitz in der Textplatte des Instruments passt.
– Den Deckel an der Vorderseite des Oszillografen befestigen.
– Den Knopf hineindrücken und eine viertel Umdrehung nach rechts drehen.

WARNUNG

In diesem Gerät werden hohe Spannungen erzeugt. Deshalb sollte es niemals in geöffnetem Zustand eingeschaltet werden. Vor Wartungsarbeiten ist der Netzstecker zu ziehen oder die externe Spannungsquelle abzuschalten und ist dafür zu sorgen, dass alle Hochspannung führende Teile entladen sind.

2.1.2. NETZSPANNUNGSEINSTELLUNG UND SICHERUNGEN

Vor dem Einschalten ist das Gerät mit dem Spannungsumschalter an der Rückseite an die örtliche Netzspannung anzupassen.
Das Gerät kann mit einem Schraubenzieher auf 110 V, 127 V, 220 V und 240 V eingestellt werden.
Die gewählte Spannung ist durch eine Öffnung an der Rückseite des Geräts sichtbar.
Auf Wunsch (Spez. Transformator) kann das Gerät auch für 100 V, 120 V, 200 V und 220 V geliefert werden.
Im Sicherungshalter an der Rückwand befindet sich normalerweise eine Sicherung von 400 mA, träge. Wird das Gerät an eine Netzspannung von weniger als 200 V angeschlossen, dann muss eine 800 mA Sicherung eingebaut werden. Vor Anschluss des Oszillografen an das Netz ist die Sicherung auf Typ und richtigen Wert zu kontrollieren. Es ist verboten reparierte Sicherungen zu verwenden oder die Sicherungshalter kurz zu schliessen.

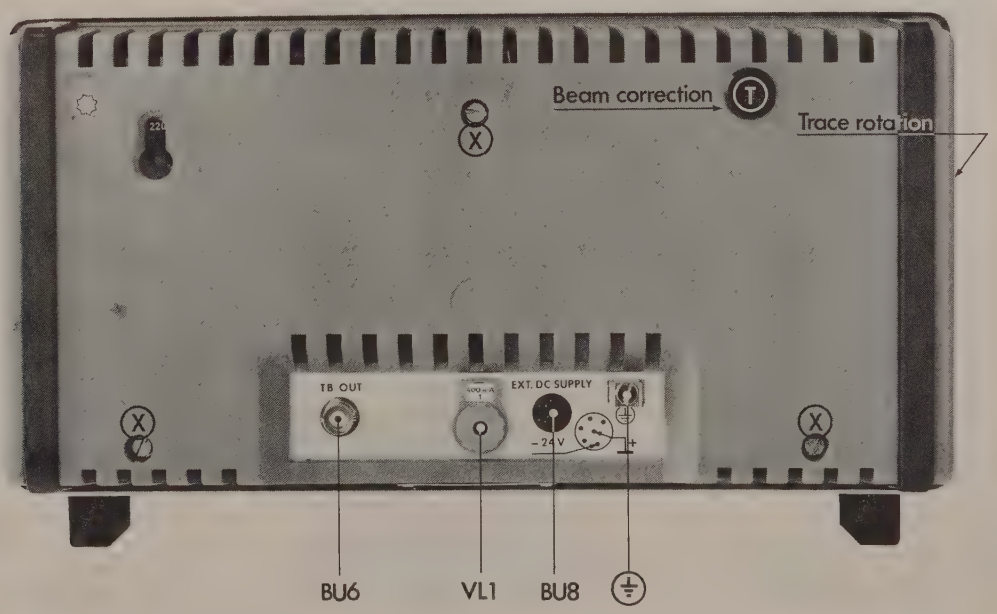


Abb. 2.1. Rückansicht mit Buchsen

2.1.3. ANSCHLUSS AN EINE EXTERNE GLEICHSPANNUNGSQUELLE

Das Gerät kann an eine externe Gleichspannung von 22 bis 30 V angeschlossen werden; die Stromaufnahme beträgt 1,25 A. Diese Spannung ist an Buchse BU8 EXT. D.C. SUPPLY anzuschliessen. DER PLUSPOL DER SPANNUNG IST MIT ERDE ZU VERBINDEN WIE ES IN DEM SCHALTBILD AN DER HINTEREN TEXTPLATTE ZU SEHEN IST, DA DER PLUSPOL DER STROMVERSORGUNG MIT DEM CHASSIS VERBUNDEN IST.
Bei einer falschen Polung der Spannungsquelle wird der Oszillograf nicht beschädigt. Beim Betrieb an einer externen Gleichspannung wird das Gerät von Sicherung VL802 (Abb. 2.2.) geschützt, die sich auf der Stromversorgungsleiterplatte befindet und nach Abnahme der Rückwand zugänglich ist. VL802 hat einen Wert von 1,25 A, träge.

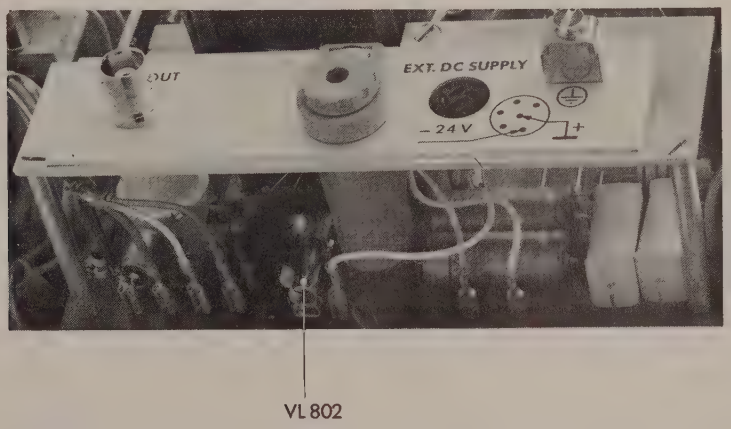


Abb. 2.2. Rückansicht mit Sicherung VL802

2.1.4. ERDUNG

Aus Sicherheitsgründen muss der Oszillograf über den Erdanschluss an der Rückseite (gekennzeichnet mit ⏚) oder über das Netzkabel, wenn das Gerät an eine Schukosteckdose angeschlossen wird, geerdet werden. Es ist auch darauf zu achten, dass die Erdverbindung des Oszillografen nicht durch ein Verlängerungskabel oder irgendeine andere Vorrichtung unterbrochen wird, die keinen Erdleiter besitzt.

2.1.5. EINSCHALTEN

Bei Netzbetrieb wird das Gerät mit dem Schalter eingeschaltet, der mit Bedienungselement INTENS gekoppelt ist. Das Netzkabel befindet sich in einem Fach unter dem Gerät. Beim Anschluss an eine externe Gleichspannung ist der Netzschalter ausser Betrieb. Das Gerät ist eingeschaltet, sobald die externe Gleichspannung angeschlossen ist. In beiden Fällen wird der Betriebszustand von der weissen Signallampe angezeigt.

Das Gerät darf in jeder Betriebslage verwendet werden, aber es ist darauf zu achten, dass die freie Luftzirkulation nicht behindert wird. Für die zulässigen Umgebungstemperaturen siehe Abschnitt 1.2.7.2.

2.1.6. INBETRIEBNAHME EINES UNTERKÜHLTEN GERÄTES

In Abschnitt 1.2. "Technische Daten" steht, dass das Gerät nach einer Anwärmzeit von 5 Minuten und in einem Temperaturbereich von +5 °C bis +40 °C die garantierten Daten einhält.
Es gibt hierbei aber eine Ausnahme. Wenn man zum Beispiel den Oszillografen nachts bei Temperaturen unter 0° im Auto lässt und dann am folgenden Morgen in einen Raum mit einer Temperatur von 25 °C bringt, tritt an den einzelnen Bauelementen Kondensation auf.
Die hochomigen Widerstände des Oszillografen verlieren durch die Leckströme herbeigerufen durch die Kondensation ihre Eigenschaften, wodurch der Oszillograf nicht mehr einwandfrei arbeitet. In diesem Fall ist etwa 2 Stunden zu warten, bis der Oszillograf akklimatisiert und alle Kondensationsflüssigkeit verdampft ist.

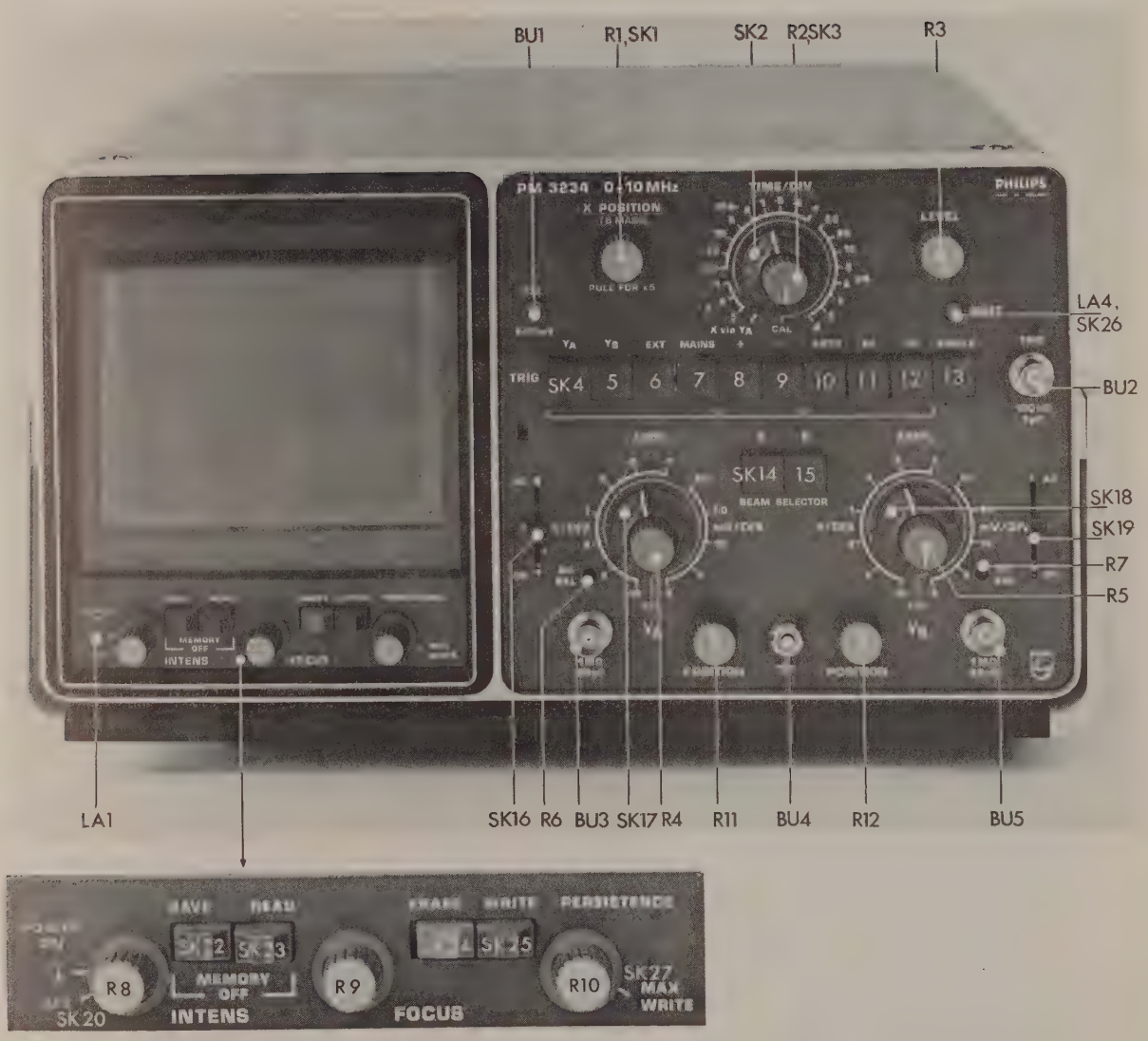


Abb. 2.3. Vorderansicht mit Bedienungsorganen und Buchsen

2.2. Bedienungsanleitungen

Vor dem Einschalten ist zu kontrollieren, ob der Oszillograf Abschnitt 2.1. "Inbetriebnahme" entsprechend angeschlossen ist und die dort beschriebenen Vorsorgemassnahmen beachtet wurden.

2.2.1. BEDIENUNGSORGANE UND BUCHSEN (Abb. 2.3.)

X POSITION (R1)	Stufenlos veränderliche Einstellung der horizontalen Lage des Elektronenstrahls. Mit Schalter für kalibrierte fünffache Dehnung der Zeitablenkung.
TIME/Div (SK2)	Einstellung des Zeitmassstabes; 21 stufiger Schalter mit einer Stellung für externe X-Ablenkung (X über Y_A).
CAL.-TIME/Div (R2/SK3)	Stufenlos veränderliche Einstellung der Zeitmassstäbe. In Stellung CAL ist der Zeitmassstab kalibriert.
LEVEL (R3)	Stufenlos veränderliche Einstellung des Pegels, bei dem der Zeitablenkgenerator startet.
CAL. (BU1)	Buchse mit Rechteckspannung von 600 mV_{ss} für Kalibrierzwecke.
TRIGGERUNG (SK4 ... 13)	10fache-Drucktaste für die Einstellung von Triggerquelle-Flanke und Art.
Y_A (SK4)	Triggersignal intern von Kanel Y_A abgenommen.
Y_B (SK5)	Triggersignal intern von Kanal Y_B abgenommen.
EXT. (SK6)	Triggersignal von der Triggereingangsbuchse abgenommen.
MAINS (SK7)	Triggersignal von einer internen Spannung mit Netzfrequenz abgenommen. Diese Triggerquelle ist bei Betrieb mit einer externen Gleichspannung nicht vorhanden.
+ (SK8)	Triggerung auf der positivgerichteten Flanke des Signals.
– (SK9)	Triggerung auf der negativgerichteten Flanke des Signals.
AUTO (SK10)	Freilaufende Zeitablenkung beim Fehlen von Triggersignalen und automatische vom zugeführten Signal abgeleitete Begrenzung des Pegeleinstellbereiches.
AC (SK11)	Triggersignal wird über Trennkondensator zugeführt.
DC (SK12)	Direkte Kopplung des Triggersignals bei einer sich langsam ändernden Spannung, oder wenn die volle Bandbreite erforderlich ist.
SINGLE (SK13)	Wenn diese Taste gedrückt ist, wird das Gerät in Betriebsart SINGLE betrieben.
RESET (SK26)	Wenn Schalter Single eingedrückt ist, läuft die Zeitablenkung nur einmal nach Drücken der Taste RESET bei Ankunft eines Triggerimpulses.
TRIGG. (BU2)	BNC Buchse für externe Triggersignale.
BEAM SELECTOR A (SK14)	Wenn diese Taste gedrückt ist, wird das Signal von Kanal Y_A vertikal dargestellt.
BEAM SELECTOR B (SK15)	Wenn diese Taste gedrückt ist, wird das Signal von Kanal Y_B vertikal dargestellt. Wenn Schalter A (SK14) und Schalter B (SK15) gedrückt sind, werden sowohl das Signal von Kanal Y_A als auch das von Kanal Y_B vertikal dargestellt.

AC-0-DC (SK16 & 19)	Dreistellungenschalter für die Signalenkopplung. AC : über einen Trennkondensator 0 : Eingangsbuchse ist nicht mit der Schaltung verbunden, die Schaltung ist geerdet DC : Gleichspannungskopplung
AMPL. (SK17 & 18)	Einstellung der vertikalen Ablenkkoeffizienten, 12stufiger Schalter.
CAL. – AMPL. (R4 & 5)	Stufenlos veränderliche Einstellung der vertikalen Ablenkkoeffizienten. In Stellung CAL. sind die Ablenkkoeffizienten kalibriert.
DC BAL. (R6 & R7)	Stufenlos veränderliche Einstellung der Gleichspannungssymmetrie der Y-Verstärker.
INTENS (SK20 & R8)	Stufenlos veränderliche Einstellung der Strahlhelligkeit. Gekoppelt mit Netzschalter.
SAVE (SK22)	Speichert die registrierte Signalform für eine längere Darstellungszeit (geschützt gegen unbeabsichtichte Löschung).
READ (SK23)	Betrachtung der registrierten Signalform (geschützt gegen unbeabsichtichte Löschung).
MEMORY OFF (SAVE und READ gleichzeitig eindrücken)	Erlaubt Betrieb des Gerätes als normalen Oszillograf.
FOCUS (R9)	Stufenlose Einstellung der Fokussierung des Elektronenstrahls.
ERASE (SK24)	Löscht die gespeicherte Darstellung, ausser in Betriebsarten SAVE und READ, wenn ERASE ausgeschaltet ist.
WRITE (SK25)	Registrierung der Signalform; bei dieser Betriebsart ist PERSISTENCE (R10) wirksam.
PERSISTANCE (R10 & SK27)	Ermöglicht regelbares Festhalten der registrierten Signalform. Gekoppelt mit Schalter MAX. WRITE.
MAX. WRITE	Steigert die Schreibgeschwindigkeit ca. 10x.
1 MOhm – 20 pF (BU3 & 5)	BNC-Eingangsbuchsen für die Y-Verstärker.
POSITION (R11 & 12)	Stufenlose Einstellung der vertikalen Lage des Elektronenstrahls.
⏚ (BU4)	Erdungsbuchse

An der Rückseite des Gerätes (Abb. 2.1.):

TB OUT (BU6)	Sägezahnausgang, BNC-Buchse
TRACE ROTATION (R813)	Ausrichtung des Strahls mit den horizontalen Rasterlinien.
EXT. DC SUPPLY (BU9)	Eingangsbuchse für externe Gleichspannung.
Schraube T	Helligkeitsausgleich beider Strahlen.

2.2.2. GRUNDEINSTELLUNGEN

Wir empfehlen das Gerät 5 Minuten vor Beginn der Messungen einzuschalten. Diese Vorwärmzeit genügt allerdings nicht, wenn das Gerät aus einem kalten Raum kommt und erst akklimatisiert werden muss (siehe auch Abschnitt 2.1.6.).

– Bei Netzbetrieb.
  Prüfen ob der Netzspannungsumschalter auf die vorhandene Netzspannung eingestellt ist. Falls erforderlich den Umschalter für die entsprechende Spannung einstellen, wie in Abschnitt 2.1.2. angegeben.
  Das Gerät einschalten.
– Bei externer Gleichspannung.
  Prüfen ob die externe Spannungsquelle richtig angeschlossen ist, mit Pluspol an Erde.

> **WARNUNG**
>
> EINE GROSSE HELLIGKEIT ÜBER LÄNGERE ZEIT KANN ZU BESCHÄDIGUNG DER ELEKTRONENSTRAHLRÖHRE FÜHREN.

Bei Betriebsart "Variable Persistence" warnt die Elektronenstrahlröhre selbst vor zu hoher Strahlintensität durch Leuchtspurzerfliessung. Wenn "Leuchtspurzerfliessung" auftritt ist die Helligkeit herabzusetzen, durch Knopf INTENS, R8 etwas nach links zu drehen.
Eine derartige Warnung gibs es bei Betriebsarten "MEMORY OFF" und "X-Y" nicht, daher ist äusserste Vorsicht geboten.

2.2.2.1. Verwendung als gewöhnlichen Oszillograf

– Die Speicherfunktion der Elektronenstrahlröhre lässt sich durch gleichzeitiges Eindrücken der Tasten SAVE, SK22 und READ, SK23 (MEMORY OFF Stellung) ausschalten.
– FOCUS, Knopf R9 und INTENS, Knopf R8 in Mittelposition stellen.
– BEAM SELECTOR Taste A (SK14) und B (SK15) eindrücken. Nicht vergessen, dass bei nicht eingedrückter BEAM SELECTOR Taste keine Darstellung gegeben ist.
– Wähle Triggerquelle, Flanke und Art. Wenn keine der Trigger Tasten gedrückt ist triggert der Oszillograf das Y_A Signal an der positiven Flanke in Betriebsart AUTO und ohne Pegelbegrenzung. Die beiden Elektronenstrahlen mit Hilfe der Knöpfe Y POSITION (R11 R12) auf dem Schirm darstellen.
  Der Oszillograf ist nun betriebsbereit. Für Korrektur der Gleichspannungssymmetrie siehe Abschnitt 3.2.4.2.

2.2.2.2. Verwendung als Speicheroszillograf

Ausgehend von Stellung MEMORY OFF, während mit Knopf INTENS (R8) eine brauchbare Helligkeit des Elektronenstrahls eingestellt wird und mit Knopf FOCUS (R9) eine optimale Schärfe, wird durch Drucktaste WRITE, SK25 einzudrücken Betriebsart STORAGE erlangt.

Persistence — Abhängig von der Stellung des Potentiometers PERSISTENCE, R10 wird eine schnell verschwindende Strahlspur auf einen grünen Hintergrund geschrieben (R10 ganz nach links) oder eine langsam verschwindende Strahlspur auf einem schwarzen Hintergrund (R10 berührt den ersten rechtsläufigen Anschlag).
Die Nachleuchtdauer ist einstellbar um bei Darstellung eines Niederfrequenz-Signals Flackern zu unterdrücken. Für ein Signal mit niedriger Wiederholungsfrequenz und kurzer Anstiegzeit, lässt sich die Nachleuchtdauer so einstellen, dass die Strahlspur ausgefüllt wird um eine deutliche und stabile Darstellung zu erhalten.

Save — Soll ein bestimmter Elektronenstrahl festgehalten werden, lässt er sich durch Eindrücken von Taste SAVE, SK22 bewahren.
Die Strahlspur ist dann gerade noch sichtbar.

Read — Die Helligkeit der gespeicherten Strahlspur wird nach Eindrücken der Taste READ, SK22 grösser, die Helligkeit wird jedoch auf Kosten der Speicherzeit erzielt.

Erase — Wird die Strahlspur nicht mehr benötigt, dann kann sie durch Eindrücken der Taste ERASE, SK23 gelöscht werden. Es kann vorkommen, dass die Strahlspur nicht gänzlich verschwindet besonders die mit beträchtlicher Helligkeit geschriebenen Teile. Dies lässt sich durch mehrmahliger Betätigung der Taste "ERASE" überwinden.

Max. Write Die Schreibgeschwindigkeit lässt sich um etwa einen Faktor 10 erhöhen. Dies geschieht durch Bedienungselement PERSISTENCE, R10 in Stellung MAX. WRITE zu bringen, das heisst den zweiten rechtsläufigen Anschlag zu berühren so dass SK27 umschaltet. Betriebsart MAX. WRITE ist für kurze Ablenkzeiten oder für Signal mit kurzer Anstiegzeit erforderlich.

2.2.3. EINGÄNGE Y_A UND Y_B UND IHRE MÖGLICHKEITEN

Der Oszillograf PM 3234 besitzt zwei identische Vertikalkanäle, die entweder zusammen mit dem Zeitablenkgenerator für Y-T-Messungen oder aber für X-Y-Messungen bis 1 MHz verwendet werden können, sowie die Möglichkeiten die Darstellungen in verschiedenen Betriebsarten zu speichern.

2.2.3.1. Y-T-Messungen

Zur Darstellung eines Signals ist einer der beiden vertikalen Kanäle mit BEAM SELECTOR A SK14 oder BEAM SELECTOR B SK15 zu wählen. Wenn beide Tasten A SK14 und B SK15 gedrückt werden, können zwei Signale gleichzeitig abgebildet werden. Der Ablenkkoeffizient lässt sich für jeden Kanal getrennt einstellen.

2.2.3.2. X-Y-Messungen

Wenn Schalter SK2 TIME/Div in Stellung X via Y_A steht, ist der Zeitablenkgenerator ausgeschaltet. Das Signal des Y_A-Kanals wird nun horizontal abgebildet. Mit den Bedienungselementen für Y_A, ausgenommen Potentiometer R11 POSITION, wird nun die X-Ablenkung eingestellt. Nur für die Verschiebung des Elektronenstrahls in horizontaler Richtung muss Potentiometer R1 X POSITION verwendet werden. Die fünffache Dehnung mit Schalter SK5 ist jedoch ausser Betrieb.
Bei dieser Einstellung sind X-Y-Messungen bis zu 100 kHz möglich.

2.2.3.3. Funktion des Schalters AC-0-DC

Die zu untersuchenden Signale sind an den Y_A-Eingang BU3 bzw. den Y_B-Eingang BU5 anzuschliessen. Je nach Zusammensetzung des Signal ist der Schalter AC-0-DC in Stellung AC oder DC zu setzen. In Stellung DC ist der Eingang direkt mit dem Y-Verstärker verbunden. Da der Y-Verstärker gleichspannungsgekoppelt ist, steht die ganze Bandbreite des Gerätes zur Verfügung. Das bedeutet, dass das vollständige Eingangssignal an die Ablenkplatten gelangt, einschliesslich einer evt. Gleichspannungskomponente, die den Strahl auf dem Schirm verschiebt.
Falls kleinere Wechselspannungen hohen Gleichspannungen überlagert sind, kann deren Darstellung zu Schwierigkeiten führen. Um in solchen Fällen die Wechselspannung sichtbar machen zu können, muss das Eingangssignal start abgeschwächt werden, wodurch der Wechselspannungsanteil nur sehr klein wiedergegeben wird.
In diesem Fall ist der Schalter AC-0-DC auf AC zu stellen.
Nun liegt ein Trennkondensator zwieschen der Eingangsbuchse und dem Y-Verstärker, der Gleichspannungen zurückhält, aber ausserdem die sehr tiefen Frequenzen unterdrückt bzw. etwas abschwächt.
Bei Rechtecksignalen mit sehr niedriger Frequenz ist eine Dachschräge der Impulse dabei nicht zu vermeiden.
In Stellung 0 des Schalters AC-0-DC kann man schnell den Nullpegel bestimmen. In dieser Stellung ist der Verstärkereingang nicht mit dem Eingangssignal verbunden, sondern geerdet. Gleichzeit wird der Trennkondensator entladen, damit die zu prüfende Schaltung nicht beschädigt werden kann.

2.2.4. TRIGGERUNG

2.2.4.1. Allgemeines

Um ein stellstehendes Bild zu erhalten, muss die horizontale Ablenkung immer beim selben Punkt des Signals gestarted werden. Deshalb wird der Zeitablenkgenerator von einem kurzen Triggerimpuls gestartet, der in der Triggereinheit (Schmitt-Trigger) geformt und von einem Signal gesteuert wird, das dem vertikalen Eingangssignal oder einer externen Spannungsquelle entnommen wird.

2.2.4.2. Triggerkopplung

AC Wenn das Eingangssignal eine Gleichspannungskomponente enthält, kommt es vor, dass mit dem Pegelpotentiometer nicht der richtige Gleichspannungspegel für den Schmitt-Trigger eingestellt werden kann. In diesem Fall ist mit Wechselspannungskopplung zu arbeiten. Die Wechselspannungskopplung erhält man durch Einfügen eines Kondensators in die Triggerleitung. Dies hat den Vorteil, dass trotzdem Gleichspannungskopplung für die Y-Kanäle erhalten bleibt.

DC Eine Gleichspannungskopplung ist zweckmässig, wenn der Mittelwert des Signals schwankt. Diese Art von Signalen tritt oft in Digitalsystemen auf. Bei Wechselspannungskopplung würde der Triggerpunkt dann nicht festliegen, wodurch das Oszillogramm zu zittern beginnt oder die Triggerung ganz ausfällt.

2.2.4.3. Triggerpegel

Bei einem komplizierten Signal mit meheren periodisch auftretenden nicht identischen Spannungsformen muss die Zeitablenkung immer bei derselben Spannungsform gestartet werden, um ein stillstehende Oszillogramm zu erhalten. Dies ist möglich, wenn irgenein Teil des Kurvenzuges eine abweichende Amplitude hat. Mit dem Knopf LEVEL kann der Triggerpegel so eingestellt werden, dass nur diese grössere Spannungsabweichung den eingestellten Pegel überschreitet.
Die Pegeleinstellung ist auch sehr nützlich, wenn zwei Signale genau verglichen werden sollen, z.B. bei Phasenmessungen. Mit der Pegeleinstellung kann der Startpunkt der beiden Kurven so gegeneinander verschoben werden, dass er auf der mittleren Rasterlinie liegt.

2.2.4.4. Automatische Triggerung

Die automatische Triggerung – Schalter AUTO gedrückt – wird wegen der einfachen Bedienung am häufigsten gewählt. Bei dieser Triggerart können die verschiedenartigsten Signalformen abgebildet werden, ohne dass irgendeines der Triggerbedienungsorgane eingestellt werden muss. Wenn kein Triggersignal vorhanden ist, bleibt auf dem Schirm eine Nullinie sichtbar und erleichtert damit den Nullpunktvergleich. Bei dieser Triggerart lässt sich der Pegel über den Spitze-Spitze-Wert der Wechselspannungskomponente des Signals einstellen. Wenn keiner der Schalter AUTO, AC, oder DC gedrückt ist, triggert der Oszillograf automatisch, aber über den gesamten zur Verfügung stehenden Pegelbereich. Dies hat den Vorteil, dass immer eine Linie auf dem Schirm zu sehen ist, auch wenn keine der Triggertasten gedrückt ist.

2.2.4.5. Externe Triggerung

Mit externer Triggerung wird bei Signalen mit stark schwankender Amplitude gearbeitet, sofern ein Signal mit konstanter Amplitude und gleicher Frequenz zur Verfügung steht. Noch wichtiger ist die externe Triggerung bei komplexen Signalen und Impulsmustern, um Doppelbilder zu vermeiden.
Man braucht dann nicht bei jeder Änderung des Eingangssignals den Triggerpegel neu einzustellen.

2.2.4.6. Triggerung mit Netzfrequenz

In diesem Falle ist das Triggersignal eine Sinusspannung mit Netzfrequenz. Diese Triggerquelle kann verwendet werden, wenn das zu untersuchende Signal mit der Netzfrequenz gekoppelt ist; z.B. zur Untersuchung der Brummkomponente eines Signals.

2.2.4.7. Stellung SINGLE und Verwendung der Knopfes "RESET"

Wenn einmalige Vorgänge beobachtet werden müssen, empfiehlt es sich oft, sicherzustellen, dass nur ein Sägezahn erzeugt wird, selbst wenn die Möglichkeit bestünde, nach Darstellung dieses Vorgangs verschiedene Triggerimpulse zu erzeugen. Der betreffende einmalige Sägezahn soll selbstverständlich von einem Triggerimpuls getriggert werden.
Hierzu den Betriebsartenschalter in Stellung SINGLE bringen.
Der erste Impuls, der nach Betätigung des Knopfes RESET erscheint, startet den Zeitablenkgenerator.
Das Bild wird nur einmal geschrieben. Die Zeitablenkung wird dann blockiert, bis Knopf RESET wieder betätigt wird.
Die Lampe in Knopf RESET leuchtet auf, sobald dieser Knopf betätigt wird und erlischt, sobald der Sägezahn beginnt.

2.2.5. DEHNUNG DER ZEITABLENKUNG

Die Dehnung wird mit einem Schiebeschalter eingestellt. Wenn dieser Schalter sich in Stellung x5 befindet, ist die Zeitablenkung auf das 5-fache erweitert. In dieser Stellung gilt der eingestellte Zeitmassstab geteilt durch 5.

2.2.6. DIE ZWEISTRAHL-SPEICHERRÖHRE

2.2.6.1. Speicher Prinzip

Der PM 3234 Oszillograf enthält eine Elektronenstrahlröhre mit einem Speichernetz mit variabler Speicherzeit. Daher kann die Elektronenstrahlröhre wie jede normale verwendet werden, jedoch mit veränderlicher Nachleuchtdauer des dargestellten Signals.

Information wird durch Schreiben des Signals des Hauptelektrodenstrahls auf eine SPEICHERSCHICHT aus nicht leitendem Material gespeichert. Als Folge der Sekundäremission von Elektronen aus dieser Schicht wird ein positives Ladungsmuster aufgebaut. Dieses Ladungsmuster wird auf der Oberfläche der Speicherschicht längere Zeit instandgehalten, auch noch nach Ausschalten der Schreibkanone.
Die Strahlspur wird auf dem Leuchtschirm mit Hilfe eines zweiten Elektronenstrahls, dessen Elektronen über den positive aufgeladenen Teil der Speicherschicht auf den Phosphor auftreffen, reproduziert.

Speicherung von Information auf nicht leitendem Material ist auf Sekundäremission basiert. Abb. 2.4. zeight das Verhältnis zwischen der Zahl der aus der Speicherschicht herausgeschlagenen Elektronen und der Zahl der auftreffenden Elektronen (Sekundäremissionsverhältnis) gegenüber dem Oberflächenpotential. Bei einem bestimmten Oberflächenpotential, V_a in Abb. 2.4., ist die Zahl der herausgeschlagenen und der auftreffenden Elektronen gleich. Diesen Punkt nennt man den ersten "cross-over" (Sekundäremissionsverhältnis = 1).

Wenn auf die Speicherschicht Elektronen von hoher Energie (Elektronen mit hoher Geschwindigkeit) auftreffen dann wird die Oberfläche positiver, da mehr Elektronen herausgeschlagen werden als Elektronen auftreffen. Wird die Oberfläche von Elektronen niedriger Energie getroffen (Elektronen mit niedriger Geschwindigkeit) als bei V_a, dann wird das Oberflächen-Potential negativer, da weniger Elektronen herausgeschlagen werden als auftreffen.

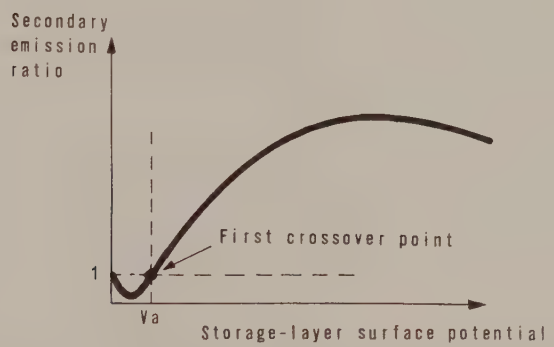


Abb. 2.4. Sekundäremisionsverhältnis-Kurve

2.2.6.2. Konstruktion und Betrieb der Speicher-Elektronenstrahlröhre

Die Zweistrahl Speicher-Elektronenstrahlröhre umfasst zwei Systeme: das Schreibsystem und das Flutsystem.

Das Zweistrahl Schreibsystem enthält eine Kanone in der zwei Strahlen erzeugt werden die unabhängig abgelinkt werden. Diese Anordnung ist als Spaltstrahlsystem (split-beam) bekannt. Bei dieser Röhre laufen beide Zeitablenklinien absolut parallel, da sie an einem Punkt erzeugt und von einem gemeinsamen Horizontal-verstärker beeinflusst werden. Da beide Strahlen in einer Kanone erzeugt werden, sind sie gegeneinander nur gering verzerrt.
Das Flutsystem besteht aus einem Paar parallel betriebenen FLUTKANONEN. Beide Kanonen enthalten eine KATHODE k, ein STEUERGITTER g1 und ein BESCHLEUNIGUNGSGITTER g2 (siehe Abb. 2.5). Beide Flutkanonen gemeinsam ist der FLUTSTRAHL-KOLLIMATOR g7, das KOLLEKTORNETZ g8, das SPEICHER NETZ g9 das die Speicherschicht trägt und der LEUCHTSCHIRM g10.

Die Flutkanonen befinden sich an einem Punkt vor den Horizontalablenkplatten und dem Netz. Das Kathoden-potential beträgt etwa +30 V, dies sind 50 V in negativer Richtung gegenüber dem Beschleunigungsgitter. Die beiden Flutkathoden emittieren eine Elektronenwolke. Diese Wolken von beiden Steuergittern g1 gesammelt, von beiden Beschleunigungsgittern g2 verschnellt und werden vom Kollimator, der aus einer Schicht an der Innenseite des Glaskolbens besteht, geformt. Die positive Spannung am Kollimator ist eine solche, dass die von der Flutkanone ausströmende Elektronenwolke gerate nur die Bildfläche der Elektronenstrahlröhre ausfüllt.
Die Wolke wird vom Kollektornetz g8 weiter in Richtung des Speichernetzes und des Leuchtschirms beschleunigt.

Nach Durchlaufen des Kollektornetzes werden die Flutelektronen vom Potential des Speichernetzes und der Speicherschichtoberfläche gesteuert.
Abb. 2.6. zeigt eine Frontansicht der Kollektor- und Speichernetze.
Die Maschen in beiden Netzen sind ca. 40 x 40 μm. Die Kathodenseite des Speichernetzes ist mit einer Schicht nicht leitenden Materials belegt, worauf die Information gespeichert wird siehe Abb. 2.7. Mit anderen Worten, es besteht eine kapazitive Kopplung zwischen Speichernetz und Speichersichtoberfläche. Diese kapazitive Kopplung ist für eine einwandfreie Speicher- und Löschfunktion unentbehrlich.
Das Potential des Speichernetzes ist etwa +2 V in Verhältnis zum Flutkathodenpotential, das heisst +32 V gegen Masse.
Das Potential V_a der Speicherschichtoberfläche wird von an das Speichernetz gelegten Schreib- und Lösch-Signalen gesteuert und variiert zwischen 2 V positive geladen und 4 V negativ geladen in Bezug auf die Flutkathode. Wenn die Speicherschichtoberfläche ein Potential von +2 V gegenüber der Kathode besitzt (siehe Abb. 2.8) dan passiert der grösste Teil der Flutelektronen die Maschen des Netzes und gelangt an den Leuchtschirm.

Die übrigen Elektronen werden von der Speicherschichtoberfläche zurückgestossen und vom Kollektornetz angezogen. Ist das Potential der Speicherschichtoberfläche gegenüber der Kathode negativ (siehe Abb. 2.9) dann vermindert die Zahl der das Speichernetz passierenden Elektronen drastisch, oder wenn der "cut-off" Pegel erreicht wird, passieren überhaupt keine Elektronen mehr das Speichernetz.

Die Nachbeschleunigungsspannung von etwa 7 kV wird an den Leuchtschirm gelegt. Elektronen die das Speichernetz passieren können werden von diesem Potential beschleunigt und treffen mit einer derartigen Geschwindigkeit auf den Leuchtschirm auf dass ein helles Bild entsteht.

Das Speichernetz lässt sich mit dem Triodengitter vergleichen. So wie das Triodengitterpotential den Anodenstrom steuert, so steuert das Speichernetz den Strom der Flutelektronen zum Schirm und damit die Strahlhelligkeit.

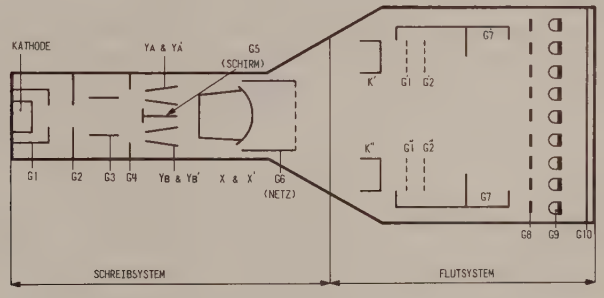


Abb. 2.5. Vereinfachtes Schaltbild der Elektronenstrahlröhre

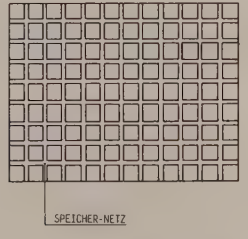


Abb. 2.6. Ausschnitt aus den Speicher- und Kollektornetzen

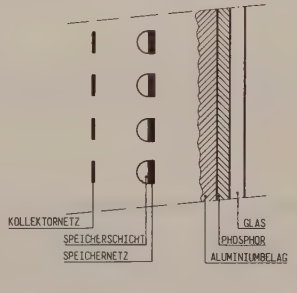


Abb. 2.7. Querschnitt des Speichersystems

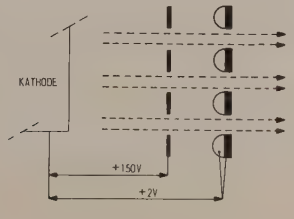


Fig. 2.8. Speichersystem mit hohem Helligkeitsgrad

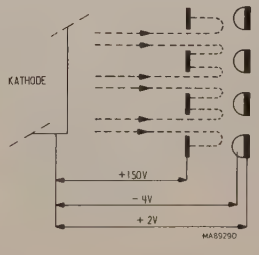


Abb. 2.9. "Cut off" des Speichersystems

2.3. Beschreibung des Blockschaltbildes (Abb. 2.10. Seite 28)

2.3.1. Y-ACHSE

Der Oszillograf PM 3234 besitzt zwei identische gleichspannungsgekoppelte Y-Verstärker, mit denen zwei Signale gleichzeitig dargestellt werden können. Jeder Verstärker enthält einen Abschwächer, einen Impedanzwandler mit Schutzschaltung, einen Vorverstärker, eine Driftkompensation, eine Triggerentnahmestufe, eine Verzögerungsschaltung und einen Endverstärker.
In diesem Gerät befindet sich die Verzögerungsschaltung (für beide Kanäle Y_A und Y_B) zwischen der Triggerentnahmestufe und dem Endverstärker, welche ein Teil der Verzögerungseinheit ist.
Die Schutzschaltung verhindert eine Beschädigung des Feldeffektransistors in der Eingangsstufe durch zu hohe Eingangsspannungen.
Die Driftkompensationsschaltung reduziert die bei hochempfindlichen Verstärkern unvermeidliche Drift.

Die Triggerentnahmestufe liefert bei interner Triggerung ein Triggersignal an den Triggervorverstärker und koppelt ausserdem das Y-Signal an den Y-Endverstärker. Wenn das Gerät als X-Y-Oszillograf verwendet wird, kann das Signal von Kanal Y_A an den X-Endverstärker angeschlossen werden. Vom Y-Endverstärker gelangt das Signal an die Y-Ablenkplatten der Elektronenstrahlröhre.
Die Verzögerungsschaltung gestattet die Wiedergabe der Vorderflanke schneller Vorgange auf dem Bildschirm.

2.3.2. TRIGGERUNG

Das Triggersignal kann entweder einem Y-Verstärker, einer externe Quelle oder intern dem Netz entnommen werden. Letzteres ist nicht möglich, wenn das Gerät mit einer externen Gleichspannung betrieben wird. Das Triggersignal kommt an den Triggerimpulsformer, der eindeutige Triggerimpulse zum Starten des Zeitablenkgenerators liefert. Die Triggereinheit enthält ausserdem eine Einzelablenkschaltung, die nach Eindrücken der Taste RESET und nach dem Eintreffen eines Triggerimpulses, macht, dass der Zeitablenkgenerator einen Sägezahn erzeugt.

2.3.3. ZEITABLENKUNG

Der Zeitablenkgenerator ist ein Konstantstromintegrator und liefert zwei Ausgangsspannungen. Eine Sägezahnspannung für den X-Endverstärker und die Ausgangsbuchse an der Rückseite des Gerätes und einen Torimpuls, der für die Helltastung der Elektronenstrahlröhre während der Ablenkung sorgt.

2.3.4. X-ACHSE

Der X-Endverstärker erhält sein Eingangssignal entweder vom Zeitablenkgenerator oder über den Y_A-Kanal von einer externen Spannungsquelle. Von X-Verstärker gelangt das Signal an die horizontalen Ablenkplatten der Elektronenstrahlröhre.

2.3.5. ELEKTRONENSTRAHLROHRENSCHALTUNG

Dieser Schaltungsaufbau enthält Schaltungen für Strahl-Austastung und Strahl-Helltastung, eine automatische Helligkeitssteuerung, Schaltungen die zu den Speicherfunktionen der Elektronenstrahlröhre gehören und Netzwerke zum Einstellen der Kenndaten der Röhre.
The A.B.C. Einheit (automatic brightness control = automatische Helligkeitssteuerung) gewährleistet eine praktisch konstante Bildhelligkeit oder eine ausgetastete Strahlspur in den verschiedenen Betriebsarten.
Bei dauernder Darstellungsart wird die Strahlspur von einem Signal des Zeitablenkgenerators ausgetastet und hellgetastet. Bei Betriebsart "SINGLE SWEEP" wird der Strahl von der A.B.C. Einheit ausgetastet.
Die Speicherschaltungen stellen die für den Speicherbetrieb der Elektronenstrahlröhre erforderlichen Spannungspegel und Signalformen zur Verfügung.
Die Einstell-Netzwerke enthalten Voreinstellungs-Potentiometer zur Korrektur von Strahldrehung, Astigmatismus, Verzerrung und Rechtwinkligkeit.
Die Hochspannungen für die Elektronenstrahlröhre werden von einem Spannungswandler erzeugt der auch die übrigen Speisespannungen liefert.

2.4. Kurze Prüfanleitung

Allgemeines: Dieses Prüfverfahren ist in MEMORY OFF Betriebsart auszuführen.
Für alle Speicherfunktionen siehe Abschnitt 3.2. (Prüfung und Einstellen)

> **WARNUNG**
> Minimale Strahlintensität verwenden um eine klare und gut sichtbare Darstellung zu erhalten. Zu hohe Intensität kann die Elektronenstrahlröhre beschädigen.

2.4.1. AUSGANGSSTELLUNG DER BEDIENUNGSORGANE

- Tasten SAVE, SK22 und READ, SK23 gleichzeitig eindrücken.
- Die Tasten Y_A SK4 + SK8 und BEAM SELECTOR A SK14 und B SK15 gedrückt.
- Schalter SK2 TIME/Div in Stellung 0,1 ms/Div.
- Schalter SK17 und SK18 AMPL in Stellung 0,1 V/Div.
- Schalter SK1 MAGN in x1.
- Potentiometer POSITION R1, R11 und R12 in ihre Mittelstellungen.
- Potentiometer INTENS, R8 für minimale Bildhelligkeit einstellen.
- Potentiometer TIME/Div und AMPL R2, R4 und R5 in Stellung CAL.

Sofern nicht anders angegeben, müssen die Bedienungsorgane sich immer in derselben Stellung wie bei der vorausgegangenen Prüfung befinden.

2.4.2. EINSTELLUNGEN DER ELEKTRONENSTRAHLRÖHRE

- Mit den Potentiometern FOCUS (R9) und INTENS (R8) eine klare und gut sichtbare Linie einstellen.
- Die beiden Zeitablenklinien mit den Potentiometern POSITION (R1, R11 und R12) zentrieren.
- Prüfen, ob die Zeitablenklinie genau parallel zu den waagerechten Rasterlinien verläuft. Eine Korrektur ist mit Potentiometer R813 möglich (Abb. 3.16.).
- Die Helligkeitsgleichheit der beiden Strahlen prüfen.
  Korrektur ist mit Hilfe der Schraube T an der Rückseite des Gerätes möglich (Abb. 2.1.).

2.4.3. Y-KANÄLE

Es wird die Prüfung von Kanal Y_A beschrieben, die für Y_B geltenden Werte stehen in Klammen.

- BEAM SELECTOR B SK15 (A SK14) lösen.
- Schalter AC-0-DC SK16 und SK19 in Stellung 0.
- Schalter AMPL SK17 (SK18) in Stellung 2 mV/Div.
- Prüfen, ob die Zeitbasislinie innerhalb 0,2 Div von der Schirmmitte bleibt. Korrektur mit Potentiometer DC BAL R6 (R7).
- Schalter AC-0-DC SK16 (SK19) in Stellung DC.
- Prüfen, ob die Zeitbasislinie nicht mehr als 0,4 Div springt.
  Korrektur mit Potentiometer R126 (R326), Abb. 3.19.
- Schalter AMPL SK17 (SK18) in Stellung 0,1 V/Div.
- Eine Rechteckspannung von 600 mV_{ss} ±0,5%, 2 kHz, an die Eingangsbuchse Y_A (Y_B) BU3 (BU5) anschliessen.
- Prüfen, ob die Höhe des Oszillogramms 6 Div ±2 % beträgt.
  Korrektur mit R111 (R311), Abb. 3.18.
- Frequenz der Eingangsspannung auf 10 MHz erhöhen.
- Prüfen ob die Höhe des Oszillogramms mindestens 4,2 Div beträgt.

2.4.4. X VIA Y_A

– BEAM SELECTOR A SK14 und B SK15 drücken.
– Schalter TIME/Div SK2 in Stellung X via Y_A.
– Schalter AC-0-DC SK19 in Stellung 0.
– Eine Rechteckspannung von 600 mV_{ss} ±0,5 %, 2 kHz, an Eingang Y_A BU3 anschliessen.
– Prüfen, ob die Breite des Oszillogramms 6 Div ±3 % beträgt.
Korrektur mit Potentiometer R601 (Abb. 3.17.).

2.4.5. ZEITABLENKUNG

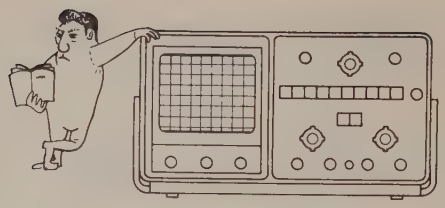
– Den Zeitmassstab in Stellung 20 μs des Schalters TIME/Div SK2 mit Zeitmarken prüfen, Toleranz ±5 %.
Korrektur mit Potentiometer R534 (Abb. 3.17.).
– Die übrigen Zeitmassstäbe prüfen, Toleranz ±5 %.

2.4.6. TRIGGERUNG

– Eine Sinusspannung von 100 mV_{ss} 10 MHz, an Eingang Y_A BU3 anschliessen.
– Prüfen, ob sich mit Hilfe von Potentiometer LEVEL R3 ein stillstehendes Bild einstellen lässt.

Notice d'emploi

1. GENERALITES



1.1. Introduction

L'oscilloscope (à mémoire) PM 3234 10 MHz a été conçu pour l'usage en laboratoire, l'entretien et l'éducation. Les amplificateurs verticaux sont équipés d'un circuit de réduction de dérive, d'une ligne à retard et d'une entrée à transistor à effet de champ complètement protégé contre la surcharge.
Tous les circuits sont entièrement transistorisés et les transistors sont montés sur support pour permettre un entretien rapide.
L'oscilloscope peut être alimenté en alternatif secteur ou en continu par une source externe.
Le PM 3234 est equipé d'une unité de ligne à retard qui produit un retard de signal pour les voies Y_A et Y_B.
Des formes d'onde sont mémorisées dans le PM 3234 à l'aide d'un canon d'électrons conventionnel, afin d'obtenir une charge sur la couche-mémoire. Cette charge est maintenue une période de temps considérable, même si l'appareil est hors-service.
Le temps d'affichage d'une image mémorisée dépend du degré de luminosité choisi et peut s'élever à plus de 2 heures. Il est possible de mémoriser plusieurs formes d'onde monocourse en vue de leur représentation simultanée.
A noter la présence du bouton ERASE, lequel permet d'effacer à tout instant le tracé mémorisé, et ce immédiatement. Le PM 3234 est également pourvu d'une commande de persistance variable sur une gamme étendue. Ceci permet une représentation stable de signaux répétés à faible vitesse, sans clignotement. De plus, des signaux HF rapides sont faciles à représenter. Dans ce cas, plusieurs cycles sont nécessaires au développement de l'image sur la couche-mémoire, et ce afin d'obtenir une image nette. De telles représentations peuvent être obtenues à partir de signaux à taux de répétition d'un cycle par minute par exemple.
Les signaux monocourse, dont la vitesse est trop élevée pour leur représentation par oscilloscope conventionnel, sont visualisés grâce à la commande MAX. WRITE. Conséquence logique de la haute sensibilité requise pour ce mode est la légère dégradation de la qualité de l'image.

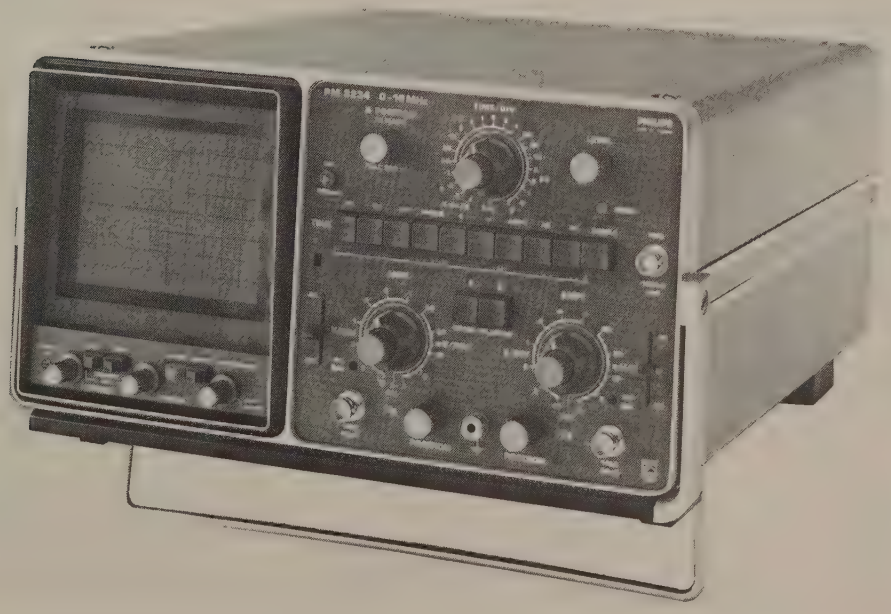


Fig. 1.1. Oscilloscope à deux faisceaux (PM 3234)

1.2. Caractéristiques techniques

Seules les valeurs indiquées avec tolérance sont garanties par l'usine pour les tensions secteur nominales.
Les chiffres sans tolérance ne servent que d'orientation et correspondent aux caractéristiques d'un appareil moyen.

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.1. TUBE A RAYONS CATHODIQUES		
Type	PHILIPS L14-130GH	Tube split-beam, gaze, post-accélérateur, phosphore, doublé de métal, mémorisation de demi-tonalité
Aire de mesure	8x10 divisions	1 div. = 0,9 cm
Tension d'accélération totale	8,5 kV	
Chevauchement des deux Systèmes	100 %	Dans les sens horizontal et vertical
Graticule	Interne	
Gravures	Divisions 8x10 avec subdivisions sur les axes centraux. Les points indiquent 10 % et 90 % de la grille de mesure.	
Persistance	En mode MEMORY OFF, moyenne courte	Persistance naturelle du phosphore
	En mode WRITE: $<$ 0,3 sec. à $\geqslant$ 1,5 min.	Continuellement variable
Temps de mémorisation	En mode READ $\geqslant$ 3 min. En mode SAVE $\geqslant$ 15 min.	
Vitesse d'écriture	$\geqslant$ 100 div/ms	En mode MEMORY OFF
	$\geqslant$ 1 div/μs	En mode MAX. WRITE
Effacement	env. 600 ms	Bouton ERASE enfoncé
1.2.2. AMPLIFICATEURS VERTICAUX		
1.2.2.1. Réponse		
Gamme de fréquence	continu à 10 MHz	-3 dB largeur de bande à couplage continu
	2 Hz à 10 MHz	-3 dB largeur de bande à couplage capacitif
Temps de montée	35 ns	
Dépassement	2 % maximum	Impulsion de test de 10 ns (temps de montée) pour 6 div. de déflexion à 1 MHz
1.2.2.2. Coefficients de déviation	2 mV/div à 10 V/div.	12 positions calibrées en progression 1-2-5 Commande continue non-calibrée 1 : $\geqslant$ 2,5
1.2.2.3. Erreur limite	± 3 %	dans la gamme +5 °C à +40 °C
	± 5 %	dans la gamme -10 °C à +55 °C
1.2.2.4. Tension d'entrée maximale admise	±400 V	tension continue + tension alternative crête
1.2.2.5. Instabilité de la position du spot		
Dérive à long terme = dérive à court terme	0,25 div./heure	valeur typique

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.2.6. Décadrage vertical	16 div.	
1.2.2.7. Gamme dynamique	24 div.	Amplitude crête-à-crête pour signaux sinusoïdaux; distorsion négligeable jusqu'au 3 MHz
1.2.2.8. Impédance d'entrée	1 MOhm//20 pF	
1.2.2.9. Temps RC d'entrée	0,1 s	Commutateur de couplage en position A.C.
1.2.2.10. Retard de signal visible	$\geqslant$ 40 ns	Différence entre voies: 0,1 division
1.2.3. MODE X-Y	X par l'intermédiaire de Y_A	L'agrandisseur x5 est hors service
Gamme de fréquence horizontale	continu à 1 MHz 2 Hz à 1 MHz	
Déphasage	5° 1°	A 100 kHz A 10 kHz
Erreur supplémentaire pour voie Y_A	±2 % ± 3 %	dans la gamme +5 °C à +40 °C dans la gamme −10 °C à +55 °C
1.2.4. BASE DE TEMPS		
1.2.4.1. Coefficients de temps	0,5 s/div. à 0,2 μs/div.	20 positions étalonnées en progression 1-2-5 Commande continue non-calibrée 1 : $\geqslant$ 2,5.
1.2.4.2. Erreur de coefficient	±5 %	Dans la gamme −10 °C à +55 °C
1.2.4.3. Expansion		
Agrandissement	5 x	commutable, étalonné
Erreur supplémentaire	±2 % ±3 %	dans la gamme +5 °C à +40 °C dans la gamme −10 °C à +55 °C
1.2.4.4. Signal de sortie de base de temps		
Tension de sortie	300 mV	Terminé par 50 Ohm
Forde électromotrice (tension en circuit ouvert)	6 V_{cc} (−2 V à +4 V)	La borne de sortie peut être cout-circuitée sans affecter les coefficients de temps
Résistance interne	1 kOhm	
1.2.4.5. Gamme de décadrage	Le début et la fin de la ligne de base de temps peuvent être visualisés	
1.2.5. DECLENCHEMENT		
1.2.5.1. Source	Interne: voie Y_A, voie Y_B ou fréquence secteur Externe	
1.2.5.2. Sensibilité de déclenchement	Interne $\leqslant$ 1 div. à 10 MHz Externe $\leqslant$ 1 V_{cc} à 10 MHz	Pour signaux sinusoïdaux

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.5.3. Impédance d'entrée	100 kOhm//5 pF	
1.2.5.4. Tension d'entrée maximale admise	± 400 V	Tension continue + tension alternative crête
1.2.5.5. Mode de déclenchement	Auto A.C. D.C. Single	20 Hz ... ⩾ 10 MHz 10 Hz ... ⩾ 10 MHz 0 Hz ... ⩾ 10 MHz
1.2.5.6. Gamme de niveau	Correspondant à la hauteur de trace 24 div. 24 V	En mode automatique En modes A.C., D.C. et single Externe
1.2.5.7. Gamme de fréquence de déclenchement	10 Hz à 10 MHz continue à 10 MHz 20 Hz à 10 MHz	couplage capacitif couplage continu couplage capacitif en mode automatique
1.2.5.8. Pente de déclenchement	+ ou −	

1.2.6. GENERATEUR D'ETALONNAGE

Type	Générateur d'ondes rectangulaires	
Tension de sortie	600 mV_{cc}	
Précision	±1 %	Dans la gamme +5 °C à +40 °C
Fréquence	environ 2 kHz	

1.2.7. CONDITIONS DE FONCTIONNEMENT

1.2.7.1. Alimentation	alternatif ou continu	
Gamme de tension nominale (lisible sur l'adaptateur) de tension secteur)	alternatif 90 V ... 140 V 180 V ... 265 V continu 22 V à 30 V	
Gamme de fréquence nominale	46 Hz à 400 Hz	
1.2.7.2. Température ambiante		
Gamme de référence	+5 °C à +40 °C	
Gamme de fonctionnement	−10 °C à +55 °C	
Température d'emmagasinage et de transport	−40 °C à +70 °C	
1.2.7.3. Position de fonctionnement	N'importe laquelle	
1.2.8. TEMPS DE CHAUFFAGE	5 minutes	A des conditions d'environnement constantes (non compris le temps de rétablissement; voir également section 2.1.6.).
1.2.9. CONSOMMATION	61 VA à 220 V alternatif 30 W à 24 V continu	1,25 A consommation de courant

DESIGNATION	*SPECIFICATION*	*INFORMATION SUPPLEMENTAIRE*
1.2.10. INTERFERENCE SECTEUR	L'appareil répond à la norme VDE Störgrad K	

1.2.11. CARACTERISTIQUES MECANIQUES

Modèle	Portable		
Dimensions	Profondeur	503 mm	Y compris le couvercle frontal
	Largeur	326 mm	Y compris poignée
	Hauteur	185 mm	Y compris pied
Poids	Environ 11,5 kg		

1.2.12. REFROIDISSEMENT	Par circulation naturelle d'air	
1.2.13. REMPLACEMENT DES COMPOSANTS	Type de production normal, transistors enfichables	

1.3. Accessoires

1.3.1. ACCESSOIRES STANDARD

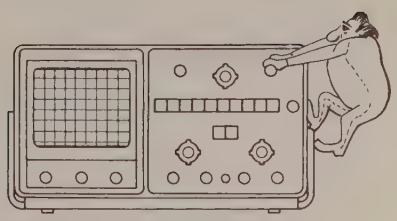
1 Couvercle frontal avec plane pour deux sondes passives et deux adaptateurs BNC 4 mm
2 Adaptateurs BNC 4 mm PM 9051
1 Notice d'emploi et d'entretien

1.3.2. ACCESSOIRES FACULTATIFS

Sondes passives (10 : 1)	: PM 9326 et PM 9327
Sondes passives (10 : 1)	: PM 9336 et PM 9336L
Sonde passive (1 : 1)	: PM 9335 et PM 9335L
Sonde passive 2 kV (100 : 1)	: PM 9358
Alimentation de sonde	: PM 9346
Sonde microminiature active (10 : 1)	: PM 9352
Sonde FET active (2 : 1)	: PM 9353
Sonde de courant	: PM 9355
Pincette miniatures pour sondes	: PM 9333
Appareil de photographie d'oscillogrammes	: PM 9380
Adaptateur (oscilloscope - PM 9380)	: PM 9379
Set de montage en rack 19"	: PM 9359

Voir également chapitre 3.5. "Information concerning accessories".

2. MODE D'EMPLOI



2.1. Installation

2.1.1. DEPOSE ET REPOSE DU COUVERCLE FRONTAL

Dépose: – Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche
– Enlever le couvercle

Repose: – Aligner la clef du bouton de verrouillage avec la fente pratiquée dans la plaque de texte de l'appareil
– Fixer le couvercle à l'avant de l'oscilloscope
– Enfoncer le bouton et le tourner d'un quart de tour vers la droite.

ATTENTION

Cet appareil produit de hautes tensions et ne peut être utilisé avec les couvercles déposés. La fiche secteur ou la source de tension externe doit être déconnectée avant tout entretien et tous les points a haute tension déchargés.

2.1.2. ADAPTATION AU SECTEUR ET FUSIBLES

Avant l'enclenchement, l'instrument doit être reglé sur la tension secteur locale à l'aide de l'adaptateur de tension situé à l'arrière de l'instrument.
Il est possible de régler l'instrument sur 110 V, 127 V, 220 V et 240 V à l'aide d'un tournevis. La tension sélectionnée est visible par l'ouverture à l'arrière.
L'instrument peut être adapté en option sur 100 V, 120 V, 200 V et 220 V à l'aide d'un transformateur spécial.
Le porte-fusible à l'arrière est normalement muni d'un fusible secteur 400 mA à action différée; cependant, si l'appareil est branché à une tension secteur intérieure à 200 V, un fusible de 800 mA doit être monté.
Vérifier si le fusible approprié est montré avant de brancher l'oscilloscope au secteur. L'usage de fusibles réparés et le court-circuitage des porte-fusibles sont strictement défendus.

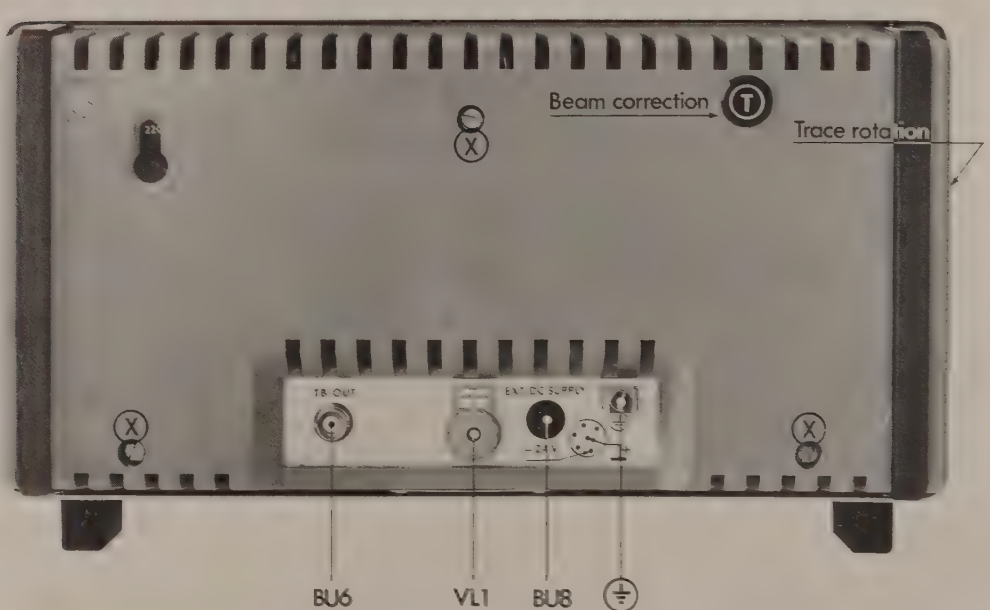


Fig. 2.1. Vue arrière montrant les douilles

2.1.3. ALIMENTATION PAR UNE SOURCE CONTINUE EXTERNE

L'appareil peut être alimenté par une source continue externe de 22 V à 30 V; 0,85 A. Cette tension doit être appliquée à la douille BU8 EXT. D.C. SUPPLY.
LA BORNE POSITIVE DE LA SOURCE DE TENSION DOIT ETRE CONNECTEE A LA TERRE. ETANT DONNE QUE LA PARTIE POSITIVE DE L'ALIMENTATION EST CONNECTEE AU CHASSIS.
L'appareil est protégé contre la connexion inverse. En cas d'alimentation continue externe, l'appareil est protégé par le fusible VL802 (Fig. 2.2.) sur la platine d'alimentation et accessible après dépose du couvercle arrière VL802 est un fusible 1,25 à action différée.

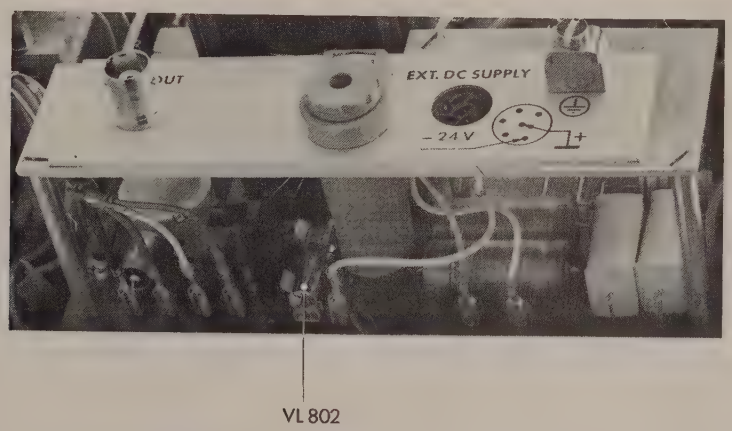


Fig. 2.2. Vue arrière montrant le fusible VL802

2.1.4. MISE A LA TERRE

Pour la sécurité l'oscilloscope doit être connecté à la terre par l'intermédiaire de la borne de terre arrière (symbole ⏚) ou du cordon secteur à condition que la douille d'alimentation soit équipée d'une connexion de terre.
Faire en sorte que la ligne de terre vers l'oscilloscope ne soit pas interrompue par l'usage d'un câble ou d'un dispositif de prolongement non raccordé à un conducteur à la terre.

2.1.5. ENCLENCHEMENT

En cas de branchement au secteur, l'appareil est enclenché par le commutateur secteur de la commande INTENS.
Le cordon secteur est placé dans un compartiment au fond de l'appareil.

En cas d'alimentation continue externe, le commutateur secteur n'a aucune fonction et l'appareil est enclenché dès que la source externe est connectée. Dans les deux cas, la position enclenchée est indiquée par la lampe témoin blanche. L'appareil peut être utilisée dans toutes les positions en tenant compte toutefois de la bonne circulation d'air. Pour les conditions thermiques, voir section 1.2.7.2.

2.1.6. PASSAGE D'UN ENDROIT FROID DANS UN ENDROIT CHAUD

A la section 1.2. il est spécifié que l'appareil fonctionne dans les limites des spécifications après une période de chauffage de cinq minutes et à une température ambiante entre +5 °C et +40 °C.
Il y a cependant une exception. Si, après avoir laissé l'oscilloscope dans sa voiture alors qu'il gèle, on le place le lendemain matin dans une pièce à 25 °C, il y aura condensation sur les composants.

Les résistances à haute impédance perdent leur propriété ohmique du fait des courants de fuite dus à la condensation; dans ce cas, l'oscilloscope ne fonctionne pas selon les spécifications. Il faut alors attendre environ deux heures avant que la condensation soit éliminée et que l'oscilloscope puisse être utilisé.

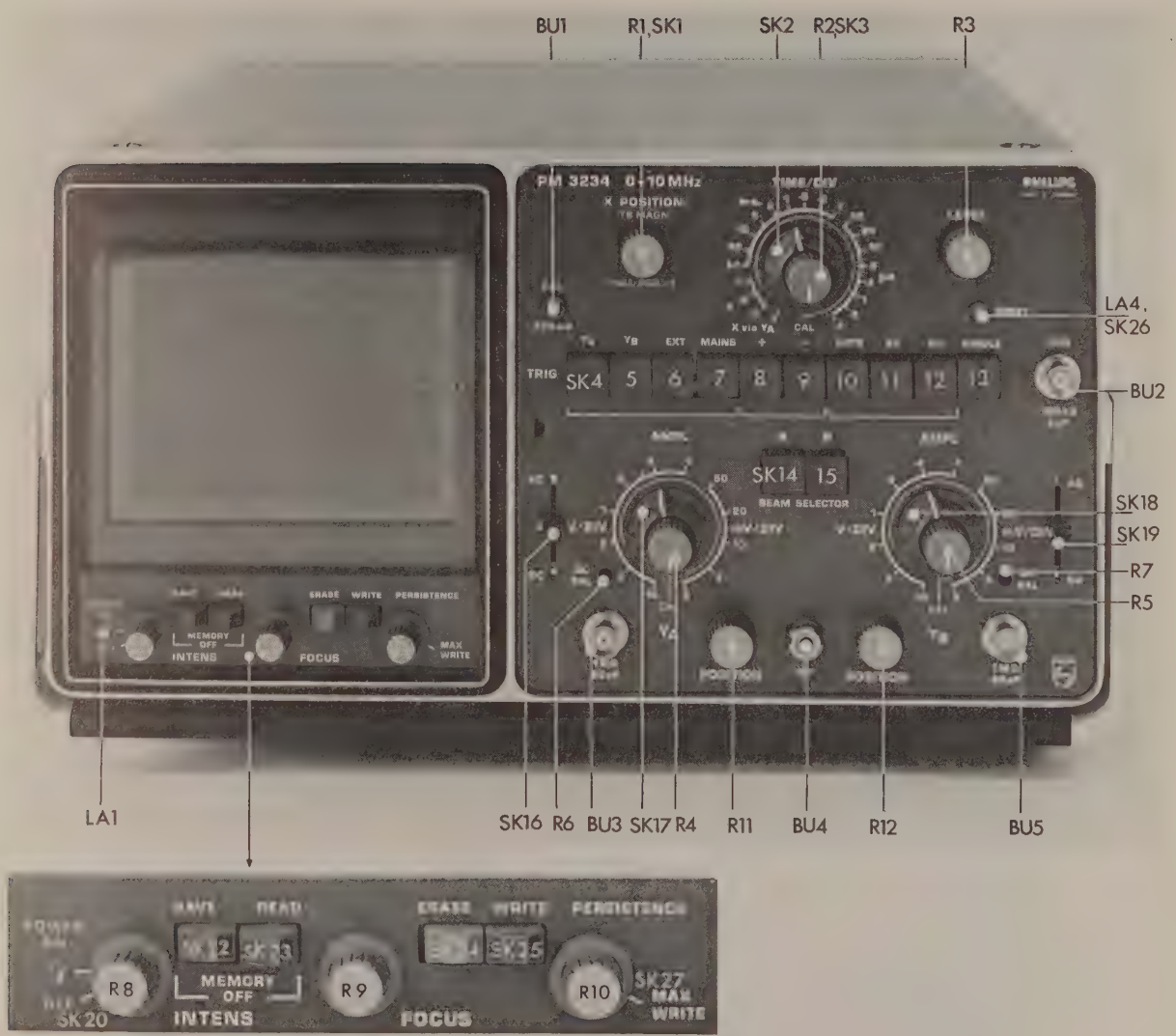


Fig. 2.3. Vue frontale montrant les commendes et douilles

2.2. Manipulation

Avant l'enclenchement s'assurer que l'oscilloscope a été installé correctement conformément au chapitre 2.1. Installation, et que toutes les précautions ont été prises.

2.2.1. COMMANDES ET DOUILLES (Fig. 2.3.)

X POSITION (R1)	Commande continuellement variable pour positionnement horizontal de la représentation.
MAGN. (SK1)	Cette commande comporte un commutateur pour agrandissement 5x de la base de temps.
TIME/div (SK2)	Commande de coefficient de temps de la base de temps; commutateur à 21 positions, dont une position pour déviation externe X (X via Y_A).
CAL. - TIME/div. (R2/SK3)	Commande continuellement variable des coefficients de temps. En position CAL. les coefficients de temps sont étalonnés.
LEVEL (R3)	Commande continuellement variable afin de sélectionner le niveau auquel le générateur de base de temps démarre.
CAL. (BU1)	Sortie pour tension rectangulaire de 600 mV_{cc} à des fins d'étalonnage.
TRIGGERING (SK4...13)	Commandes pour source, pente et mode de déclenchement; bouton-poussoir à 10 positions.
Y_A (SK4)	Signal de déclenchement interne dérivé du canal Y_A
Y_B (SK5)	Signal de déclenchement interne dérivé du canal Y_B
EXT. (SK6)	Signal de déclenchement dérivé d'une tension appliquée à la douille d'entrée TRIGG.
MAINS (SK7)	Signal de déclenchement dérivé d'une tension interne avec la fréquence secteur. Cette source de déclenchement n'exerce aucune fonction lorsque l'appareil est alimenté par une tension continue externe.
+ (SK8)	Pour déclenchement sur la pente positive du signal.
– (SK9)	Pour déclenchement sur la pente négative du signal.
AUTO (SK10)	Pour base de temps libre en l'absence de signaux de déclenchement et de limitation automatique de la gamme de commande LEVEL.
AC (SK11)	Déclenchement avec condensateur de couplage sur le chemin du signal de déclenchement.
DC (SK12)	Couplage direct pour déclenchement sur une tension variat lentement ou largeur de bande totale.
SINGLE (SK13)	Si ce bouton est enfoncé, l'instrument fonctionne en mode de balayage SINGLE.
RESET (SK26)	Si le bouton SINGLE est enfoncé, la base de temps n'est actionnée qu'après avoir enfoncé RESET à la réception d'une impulsion de déclenchement.
TRIGG (BU2)	Connecteur BNC d'entrée pour signaux de déclenchement externe.
BEAM SELECTOR A (SK14)	Lorsque ce bouton-poussoir est enfoncé, la déviation verticale s'obtient par le signal appliqué à l'entrée de voie Y_A.

BEAM SELECTOR B (SK15)	Lorsque ce bouton-poussoir est enfoncé, la déviation verticale s'obtient par le signal appliqué à l'entrée de voie Y_B. Si les commutateurs A (SK14) et B (SK15) sont tous deux enfoncés, la déviation verticale par le signal appliqué à l'entrée de voie Y_A et par celui appliqué à l'entrée de voie Y_B.
AC-0-DC (SK16 et 19)	Commutateur à trois positions pour couplage de signal AC : par l'intermédiaire d'un condensateur de couplage 0 : interruption de la connexion entre la douille d'entrée et le circuit d'entrée, ce dernier étant mis à la terre DC : couplage direct
AMPL. (SK17 et 18)	Commande des coefficients de déviation, cummutateur à 12 positions.
CAL.-AMPL. (R4 et 5)	Commande continuellement variable des coefficients de déviation verticale. En position CAL, le coefficient de déviation est étalonné.
DC BAL. (R6 et 7)	Commande continuellement variable pour balance de tension continue de l'amplificateur vertical.
INTENS (SK20 et R8)	Commande continuellement variable de l'intensité de trace. Comprend l'interrupteur secteur.
SAVE (SK22)	Permet de stocker l'onde enregistrée pour un temps de visualisation plus long (protégé contre effacement accidental)
READ (SK23)	Permet d'observer l'onde enregistrée (protégé contre effacement accidental)
MEMORY OFF (par ex. SAVE et READ enfoncés simultanément)	Permet le fonctionnement normal de l'appareil.
FOCUS (R9)	Commande continuellement variable de la focalisation du faisceau électronique
ERASE (SK24)	Efface le tracé stocké, mais pas en modes SAVE et READ où le condition ERASE est non-active.
WRITE (SK25)	Enregistre la forme d'onde; fonctionne en mode PERSISTENCE
PERSISTENCE (R10 et SK27)	Permet la rétention variable de l'onde enregistrée. Comprend le commutateur MAX. WRITE
MAX. WRITE	Permet d'accroître la vitesse d'écriture d'un facteur 10 environ.
1 MOhm – 20 pF (BU3 et 5)	Connecteur BNC d'entrée pour signaux de déviation verticale.
POSITION (R11 et 12)	Commande continuellement variable pour positionnement vertical de la réprésentation.
⏚ (BU4)	Douille de terre

A l'arrière de l'appareil (Fig. 2.1.):

TB OUT (BU6)	Connecteur BNC de sortie en dents de scie
TRACE ROTATION (R813)	Permet d'aligner la trace sur les lignes horizontale de graticule
EX.DC SUPPLY (BU8)	Douille d'entrée pour alimentation continue
Vis T	Permet d'égaliser la luminosité des deux traces

2.2.2. REGLAGES PRELIMINAIRES

Un temps de chauffage de 5 minutes est nécessaire avant de procéder à une mesure. Ce temps n'inclut pas le temps de rétablissement lorsque l'appareil sort d'un endroit froid (voir également section 2.1.6.).

- En cas d'alimentation secteur:
  Vérifier si l'adaptateur de tension est réglé sur la tension secteur locale.
  Au besoin, régler l'adaptateur sur la tension secteur appropriée conformément à 2.1.2.
- En cas d'alimentation continue externe:
  Vérifier si la source externe est connectée correctement avec borne positive à la terre.

ATTENTION
UNE FORTE INTENSITE DE LONGUE DUREE PEUT ENDOMMAGER LE TRC

En mode "Persistance variable" le TRC indique que l'intensité est trop forte par expansion du point ou de la trace. Dans ce cas, l'intensité doit être diminuée en tournant le bouton INTENS R8 légèrement vers la gauche.

En modes "MEMORY OFF" et "X-Y" une telle indication n'est pas donnée, aussie faudra-t-il faire tout spécialement attention.

2.2.2.1. Utilisation normale

- La fonction mémoire du TRC peut être déclenchée en enfonçant simultanément les boutons SAVE SK22 et READ SK23 (position MEMORY OFF).
- Mettre les commandes FOCUS (R9) et INTENS (R8) en position médiane.
- Enfoncer les boutons BEAM SELECTOR A SK14 et B SK15. Veiller à ce qu'il n'y ait pas de représentation lorsque le bouton BEAM SELECTOR n'est pas enfoncé.
- Sélectionner la source de déclenchement, la pente et le mode.
  Si le bouton TRIGG n'est pas enfoncé, l'oscilloscope déclenche au signal Y_A sur la pente positive et en mode AUTO sans limitation de gamme de niveau.
- Afficher les deux traces à l'aide des commandes Y POSITION R11 et R12.
  L'oscilloscope est alors prêt à l'usage. Pour la correction de l'équilibre continu, se référer à la section 3.2.4.2.

2.2.2.2. Utilisation mémoire

En portant de la position MEMORY OFF, le mode de stockage peut être obtenu en enfonçant le bouton-poussoir WRITE SK25, à condition que la commande INTENS R8 soit réglée pour intensité appropriée de trace et la commande FOCUS R9 sur netteté maximale.

"Persistance" — En fonction de la position du potentiomètre PERSISTENCE R10, une trace à disparation rapide est écrite sur fond vert (R10 en position extrême gauche) et une trace à disparation lente sur fond noir (R10 en position "premier arrêt droite").
La persistence peut être réglée de telle sorte que tout clignotement est supprimée à la représentation d'un signal basse fréquence. Pour un signal à faible taux de répétition et court temps de montée, la persistance peut être réglée pour remplir la trace et donc obtenir une représentation nette et constante.

"Save" — Si une trace particulière doit être retenue, on enfonce le bouton SAVE SK22. Dans ce cas, la trace est à peine visible.

"Read" — L'intensité de la trace mémorisée est accrue en enfonçant le bouton READ, SK23. à noter cependant que la luminosité augmente aux dépens du temps de stockage.

"Erase" — Lorsque la trace n'est plus nécessaire, elle peut être effacée en enfonçant le bouton ERASE SK24. Il se peut que la trace n'ait pas disparu entièrement, et plus particulièrement les parties affichées avec luminosité substantielle. Ceci peut être corrigé avec un appui prolongé sur le bouton ERASE.

"Max. write" — La vitesse d'écriture peut être accrue d'un facteur 10 environ en mettant la commande PERSISTENCE R10 en position MAX. WRITE (deuxième arrêt droite), de sorte que le commutateur SK27 est permuté.
Le mode MAX. WRITE est requis pour brefs temps de balayage ou pour signaux à court temps de montée.

2.2.3. ENTREES Y_A ET Y_B ET LEURS POSSIBILITES

Le PM 3234 est pourvu de deux voies verticales indiques pouvant être utilisés pour des mesure YT avec le générateur de base de temps ou des mesures XY pour des fréquences allant jusqu'à 1 MHz, et une possibilité de stocker les représentations dans différents modes.

2.2.3.1. Mesures YT

Pour représenter un signal, une des deux voies verticales peut être sélectionné à l'aide de BEAM SELECTOR A (SK14) ou BEAM SELECTOR B (SK15). Lorsque les deux bouton-poussoirs A et B (SK14 et SK15) sont enfoncés, deux signaux peuvent être représentés simultanément. Le coefficient de déviation Y peut être réglé individuellement pour chaque voie.

2.2.3.2. Mesures XY

Lorsque le commutateur TIME/div. SK2 est mis en position X via Y_A, le générateur de base de temps est mis hors circuit. Le signal de voie Y_A est réprésenté horizontalement. Les commandes Y_A (à l'exception du potentiomètre POSITION R11) commandent alors la déviation X. Le positionnement de la trace en sens horizontal est encore possible avec la commande POSITION R1. Le commutateur MAGNIFIER x5 (SK1) est hors service. Dans ce mode, des mesures XY sont possibles jusqu'à une fréquence de 100 kHz.

2.2.3.3. Influence du commutateur AC-0-DC

Les signaux à étudier peuvent être appliqués à la douille d'entrée Y_A (BU3) et/ou à la douille d'entrée Y_B (BU5).
Le commutateur AC-0-DC doit être réglé en position AC ou DC en fonction de la composition du signal. En position DC l'entrée est couplée directement avec l'amplificateur Y. Etant donné que l'amplificateur est couplé en continu, la largeur de bande totale de l'appareil est disponible. Ceci signifie que les tensions d'entrée totales sont conduites aux plaques de déflexion, ce qui implique que les composantes continues correspondent à des décadrages de trace sur l'écran.
Ceci peut entraîner des difficultés lorsque des signaux alternatifs superposés à de hautes tensions continues doivent être représentés.

Pour visualiser le signal alternatif dans ces cas, une plus forte atténuation est nécessaire, le signal alternatif étant alors fortement atténué.

Au cas où le commutateur AC-0-DC est en position AC, un condensateur de blocage est connecté entre la douille d'entrée et l'amplificateur Y. De ce fait, les tensions continues sont bloquées, mais les basses fréquences également sont supprimées ou atténuées. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.
En position 0 du commutateur AC-0-DC, il est possible de déterminer rapidement le niveau continu zéro. Dans cette position, la connexion entre l'entrée de l'amplificateur et la douille d'entrée est interrompue. Le condensateur de blocage est également déchargé afin d'empêcher tout endommagement du circuit testé à la suite d'une haute charge éventuelle.

2.2.4. DECLENCHEMENT

2.2.4.1. Généralités

Pour obtenir une trace stationnaire, la déviation horizontale doit toujours être démarrée à un point fixe du signal. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans une unité de déclenchement et contrôle par un signal provenant du signal d'entrée vertical ou d'une source externe.

2.2.4.2. Accouplement de déclenchement

AC Lorsque la tension du signal contient un composant continu, le déclenchement peut cesser lorsque le potentiomètre de niveau ne produit plus le niveau requis par le déclencheur de Schmitt. Dans ce cas, il est utile d'appliquer un couplage capacitif. Le couplage capacitif s'obtient en insérant un condensateur sur la piste de déclenchement. Ceci signifie que le signal de visualisation peut encore être couplé en continu avec les canaux Y.

DC Le couplage continu est utile lorsque la valeur moyenne du signal varie. Cette sorte de signal apparaît souvent dans des systèmes digitaux.
Avec le couplage capacitif le point de déclenchement n'est probablement pas fixe, ce qui entraînerait l'instabilité de la base de temps ou même une certaine perte de déclenchement.

2.2.4.3. Niveau de déclenchement

En cas de signal compliqué dans lequel un certain nombre de tensions non-identiques apparaissent périodiquement, l'axe de temps doit toujours être démarré avec la même tension, et ce afin d'obtenir une trace stationnaire.
Ceci est possible lorsqu'un des détails a une amplitude différente.
Avec le bouton LEVEL, le niveau de déclenchement peut être réglé de telle sorte que seule cette plus grande variation de tension passe ce niveau. La commande LEVEL est également très utile lorsque deux signaux doivent être comparés exactement, pour des mesures de phase par exemple. La commande LEVEL permet de décadrer le point de démarrage des traces exactement sur la ligne de graticule centrale.

2.2.4.4. Déclenchement automatique

Le déclenchement automatique (commutateur AUT enfoncé) est surtout utilisé pour sa simplicité. Dans ce mode il est possible de représenter une grande variété d'impulsions d'amplitude et de forme différentes, et ce sans devoir actionner une des commandes de déclenchement. Lorsqu'aucun signal de déclenchement n'est présent, une ligne de base de temps reste visible sur l'écran. Ceci est utile à des fins de référence du zéro. Dans ce mode de déclenchement, le niveau peut être réglé sur la valeur crête-à-crête du composant alternatif du signal. Si aucun des commutateurs AUTO, AC ou DC n'est enfoncé, l'oscilloscope fonctionne en mode automatique, la gamme de niveau totale étant alors disponible. Une trace est alors toujours visible même lorsqu'aucun bouton-poussoir TRIGG. n'est enfoncé.

2.2.4.5. Déclenchement externe

Le déclenchement externe est appliqué pour des signaux à amplitude fortement variable, lorsqu'un signal d'amplitude fixe et de fréquence égale est disponible. Le déclenchement externe est même plus important en cas de signaux et des courbes d'impulsions complexes.
Le déclenchement externe peut alors être utilisé pour éviter la double trace.
C'est pourquoi il n'est pas nécessaire de rajuster le réglage de niveau à chaque variation du signal d'entrée.

2.2.4.6. Déclenchement avec fréquence secteur

Dans ce cas, le signal de déclenchement est une sinusoïdale à fréquence secteur.
Cette source de déclenchement est utile lorsque la fréquence du signal observé est couplée avec la fréquence secteur. Par exemple, il est possible de reconnaître le composant de bruit d'un signal en déclenchant sur ce composant.

2.2.4.7. Position SINGLE et utilisation du bouton-poussoir RESET

Lors de l'observation de phénomènes n'ayant lieu qu'une fois, il est souvent recommandé de s'assurer qu'un seul balayage soit engendré, même si plusieurs impulsions de déclenchement se produisent après le phénomène en question.
Ce balayage unique doit évidemment être déclenché par une impulsion de déclenchement.
A cet effet, le commutateur de mode doit être mis en position "SINGLE". Lorsqu'on a appuyé sur le bouton RESET, l'impulsion suivante de déclenchement démarre le générateur de base de temps. Le spot n'effectue qu'un seul passage sur l'écran. La base de temps est alors bloquée jusqu'à ce que le bouton poussoir RESET soit à nouveau mis en service.
La lampe se trouvant à l'intérieur du bouton-poussoir RESET s'allume dès que ce bouton est actionné et s'éteint lorsque la dent de scie est démarrée.

2.2.5. AGRANDISSEUR DE BASE DE TEMPS

Cet agrandisseur est piloté par un commutateur push-pull. Lorsque ce commutateur est en position x5, la vitesse de balayage de la base de temps est agrandie 5 fois. Dans cette position, le temps de balayage est déterminé en divisant par cinq la valeur indiquée par TIME/div.

2.2.6. TUBE-MEMOIRE DOUBLE FAISCEAU

2.2.6.1. Principe de stockage

L'oscilloscope PM 3234 contient un tube à rayons cathodiques avec grille de stockage à temps de stockage variable. Le TRC peut donc être utilisé normalement, mais à persistance variable du signal représenté. L'information est stockée par écriture du signal faisceau principal sur une couche mémoire de matériel non-conducteur. A la suite de l'émission secondaire d'électrons par cette couche, un oscillogramme de charge positive est composé. Cet oscillogramme de charge sur la couche mémoire est retenu là pendant une durée de temps considérable, même si le canon d'écriture est hors service. La trace est retenue sur l'écran phosphore par le second faisceau dont les électrons peuvent bombarder le phosphore aux parties de couche mémoire portant une charge positive.
Le stockage de l'information sur le matériel non-conducteur est basé sur l'émission secondaire. La figure 2.4. illustre le rapport entre le nombre d'électrons sortant la couche mémoire et ceux incidents (rapport d'émission secondaire) par rapport au potentiel de surface. Pour un certain potentiel de surface V_a en Figure 2.4., le nombre d'électrons sortant la surface est égal au nombre d'électrons incidents. Ce point est appelé premier point de croisement (rapport d'émission secondaire = 1).

Si la surface de la couche mémoire est bombardée d'électrons à forte énergie (grande vitesse), la surface devient plus positive, car il y a plus d'électrons sortant qu'd'électrons incidents. Si la couche mémoire est bombardée d'électrons à énergie plus faible qu'en V_a (vitesse inférieure), le potentiel de surface devient plus négatif, car il y a moins d'électrons quittant que d'électrons bombardant.

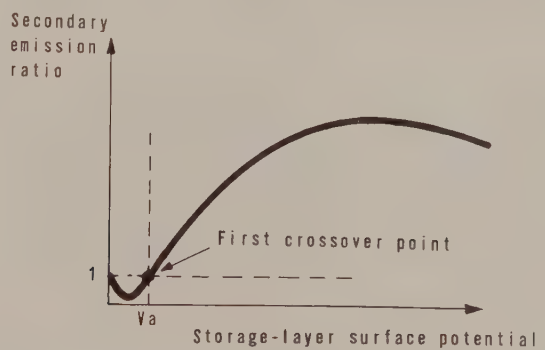


Fig. 2.4. Courbe du rapport d'émission secondaire

2.2.6.2. Construction et fonctionnement du TRC

Le tube-mémoire double faisceau comporte deux systèmes: le système d'ECRITURE et le système d'ENTRETIEN.

- La partie d'ECRITURE est formé d'un canon dans lequel deux faisceaux sont composés en vue d'une déflection indépendante. Ce dispositif est également connu sous le nom système split-beam. Dans ce tube, les deux lignes de base de temps sont exactement parallèles, car elles sont produites en un point et sous l'influence d'un amplificateur horizontal commun. Etant donné leur émission par un seul canon, les deux traces présentent une légère distorsion l'une par rapport à l'autre.
- Le système d'entretien est composé de deux CANONS DE PROJECTION actionnés en parallèle. Ces canons contiennent une CATHODE k, une GRILLE DE COMMANDE g1 et une GRILLE D'ACCELERATION g2 (voir Fig. 2.5.). Communs aux deux canons de projection sont le COLLIMATEUR g7, la GRILLE COLLECTEUR g8, la GRILLE DE STOCKAGE g9 avec couche mémoire et le LUMINOPHORE D'ECRAN g10. Les canons de projection sont placés devant les plaques de déflexion et la grille "mesh". Le potentiel de cathode est d'environ +30 V, ce qui correspond à 50 V négatif par rapport aux grilles d'accélération. Les deux systèmes de projection fournissent un nuage d'électrons. Ce nuage est combiné par les grilles de

commande g1, accéléré par les deux grilles d'accélération g2 et mis en forme par le collimateur g7, lequel constitue le revêtement de la surface interne du TRC. La tension positive sur le collimateur est telle que le nuage d'électrons projetés par le canon remplit exactement la surface utile du TRC.

Le nuage est ensuite accéléré vers la grille de stockage et l'écran utile par la grille collecteur g8. Après le passage par la grille collecteur, les électrons du canon de projection sont contrôlés par les potentiels de la grille et de la surface de la couche de stockage. La figure 2.6. illustre la vue frontale du collectuer

La figure 2.6. illustre la vue frontale du collecteur et des grilles de stockage. Les orifices des deux grilles sont d'environ 40 x 40 μm. Le côté cathode de la grille de stockage est revêtu d'un matériau non-conducteur sur lequel sont mémorisées les informations (voir Fig. 2.7.). Entre cette grille de stockage et la surface de la couche, il existe un couplage capacitif indispensable aux fonctions d'écriture et d'effacement. La grille de stockage est à environ +2 V par rapport à la cathode de canon de projection, par ex. environ +32 V par rapport à la terre.

Le potentiel V_a à la surface de couche mémoire est contrôlé par les signaux d'écriture et d'effacement, lesquels sont appliqués à la grille de stockage, et est variable entre 2 V positif et 4 V négatif en fonction de la cathode de canon de projection. Lorsque la surface de couche mémoire est à 2 V par rapport à la cathode (voir Fig. 2.8.), la plupart des électrons émis par les canons de projection traversent la grille et atteignent l'écran. Le reste de ces électrodes est repoussé par la surface de la couche mémoire et capté par la grille collecteur. Si le potentiel de la surface de couche mémoire est négatif par rapport à la cathode (voir Fig. 2.9.), le nombre des électrons qui traversent la grille de stockage est considérablement réduit et pour une certaine valeur (niveau "cut-off") aucun électron ne traverse la grille.

La tension de post-accélération d'environ 7 kV est appliquée à l'écran. Ainsi, dès que les électrons peuvent traverser la grille de stockage, ils sont accélérés par ce potentiel et viennent bombarder le luminophore de l'écran en provequant une émission lumineuse.

La grille de stockage peut être comparée à la grille d'une triode. Tout comme le potentiel de la grille de triode commande le courant d'anode, la grille de stockage commande le courant des électrons émis par les canons de projection sur l'écran et donc la brillance de la trace.

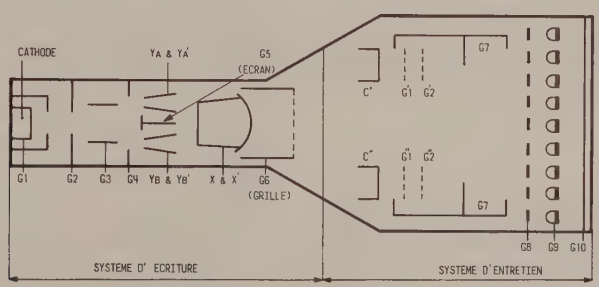


Fig. 2.5. Synoptique simplifié du tube cathodique à mémoire

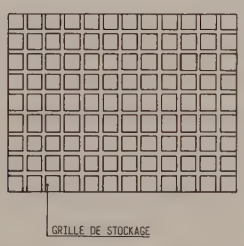


Fig. 2.6. Détail des grilles de stockage et collecteur

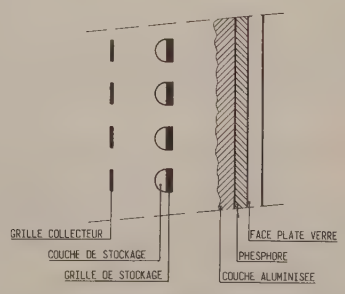


Fig. 2.7. Détail du système de mémorisation

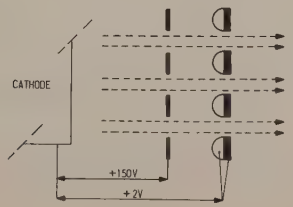


Fig. 2.8. Système de stockage à grande brillance

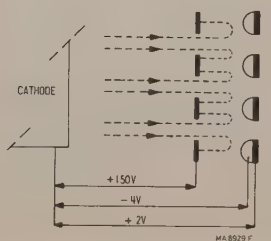


Fig. 2.9. Système de stockage au "cut-off"

2.3. Description du schéma synoptique (voir fig. 2.10. page 28)

2.3.1. AXE Y

L'oscilloscope PM 3234 est composé de deux amplificateurs verticaux indentiques à couplage continu permettant la représentation simultanée de deux signaux.
Chaque amplificateur comporte atténuateur à l'entrée, une source follower avec circuit de protection, un préamplificateur et un circuit de réduction de dérive, un étage sélectif de déclenchement, un circuit de ligne de retard et un amplificateur de sortie. L'étage sélectif de déclenchement et l'amplificateur de sortie (pour canaux Y_A et Y_B) sont couplés à l'aide du circuit de ligne à retard, qui fait partie de l'unité de ligne à retard.
Le circuit de protection empêche d'endommagement des transistors d'entrée à effet de champ à la suite d'une tension d'entrée trop élevée.
Le circuit de réduction de dérive réduit la dérive due à la haute sensibilité de l'amplificateur.
L'étage sélectif de déclenchement fournit un signal de déclenchement au préamplificateur de déclenchement en cas de déclenchement interne et accouple également le signal à visualiser l'amplificateur de sortie Y. Dans la voie Y_A le signal peut également être couplé à l'amplificateur de sortie X lorsque l'appareil est utilisé en tant qu'oscilloscope XY. Le signal est conduit de l'amplificateur de sortie Y aux plaques de déflexion Y du tube à rayons cathodiques. La ligne à retard est appliquée afin de permettre l'affichage du flanc avant de phénomènes rapides sur l'écran.

2.3.2. DECLENCHEMENT

Un signal de déclenchement peut être obtenu à partir de chaque amplificateur vertical, d'une source externe ou du secteur (interne). Le dernier signal n'est pas disponible lorsque l'appareil est alimenté par une tension continue externe. Le signal de déclenchement est conduit au conformateur d'impulsions de déclenchement lesquelles permettent le démarrage du générateur de base de temps. L'unité de déclenchement comprend un circuit de balayage simple permettant au générateur base de temps de produire une dent de scie après avoir enfoncé le bouton RESET et reçu l'impulsion de déclenchement. Ce circuit ne fonctionne que lorsque le commutateur SINGLE est enfoncé.

2.3.3. BASE DE TEMPS

Le générateur de base de temps est du type intégrateur à courant constant et fournit deux tensions de sortie. Une tension en dents de scie conduite à l'amplificateur de sortie X et à une borne de sortie à l'arrière de l'oscilloscope, et une impulsion de porte qui commande le faisceau du tube pendant le balayage.

2.3.4. AXE X

L'amplificateur de sortie X reçoit son signal d'entrée à partir du générateur de base de temps ou d'une source externe par l'intermédiaire de la voie Y_A.
Le signal est conduit de l'amplificateur X aux plaques de déviation horizontale du tube d'oscilloscope.

2.3.5. CIRCUIT DU TUBE A RAYONS CATHODIQUES

Le circuit du tube à rayons cathodiques comprend les circuits pour suppression et commande de faisceau, une unité de commande de brillance automatique, des circuits pour fonctions de stockage du tube et réseaux pour correction des caractéristiques du tube.

L'unité abc (automatic brightness control) commande de brillance automatique, assure une brillance de trace pratiquement constante ou une trace supprimée dans les différents modes d'affichage.

En mode de représentation continu, commande et suppression de trace sont obtenues par un signal émis par le générateur de base de temps. En mode de balayage simple la trace est supprimée par l'unité abc.

Les circuits de stockage fournissent les niveaux de tension et les formes d'onde nécessaires à la fonction stockage du tube.
Les régeaux de correction comprend des potentiomètres de pré-réglage pour rotation de trace, astigmatisme, distorsion et correction d'orthogonalité.

Les hautes tensions pour le tube sont produites par un convertisseur, lequel délivre également les autres tensions d'alimentation.

2.4. Bref processus de contrôle

Généralités: un bref contrôle est effectué en mode MEMORY OFF. Pour toutes les fonctions de stockage, voir chapitre 3.2. Contrôler et Réglages.

> **ATTENTION:** Utiliser une intensité minimale de faisceau afin d'obtenir une représentation nette et bien définie. Une forte intensité de longue durée peut endommager le TRC.

2.4.1. POSITIONS DE DEMARRAGE DES ORGANES DE COMMANDE

- Boutons SAVE SK22 et READ SK23 enfoncés simultanément.
- Boutons-poussoirs Y_A SK4, + SK8 et BEAM SELECTOR A SK14 & B SK15 enfoncés.
- TIME/div SK2 en position .1 ms.
- Commutateurs AMPL SK17 & SK18 en position .1 V/div.
- Commutateur MAGN SK1 en position x1.
- Potentiomètres POSITION R1, R11 et R12 en position centrale.
- Potentiomètre INTENS R8 réglés pour intensité minimale.
- Potentiomètres TIME/div et AMPL R2, R4 et R5 en position CAL.

Les organes de commande doivent être dans la même position qu'au contrôle précedent, à moins qu'indiqué différemment.

2.4.2. POSITION DU TUBE A RAYONS CATHODIQUES

- Régler les potentiomètres FOCUS R9 et INTENS R8 en position adéquate.
- Centrer les deux lignes de base à l'aide des potentiomètres POSITION R1, R11 et R12.
- Vérifier si la ligne de base de temps est exactement en parallèle avec les lignes de graticule horizontales. La correction est possible avec R813 (Fig. 3.16.).
- Vérifier l'égalité de brillance des deux faisceaux. Correction possible avec vis T à l'arrière de l'instrument (Fig. 2.1.).

2.4.3. CANAUX VERTICAUX

Seul le contrôle du canal Y_A est décrit, les éléments de canal Y_B étant indiqués entre parenthèses.

- Relâcher BEAM SELECTOR B SK15 (A SK14).
- Commutateurs AC-0-DC SK16 & SK19 en position 0.
- Commutateur AMPL SK17 (SK18) en position 2 mV/div.
- Vérifier si la ligne de base de temps reste dans les 0,2 div au centre de l'écran. La correction est possible avec le potentiomètre DC BAL R6 (R7).
- Commutateur AC-0-DC SK16 (SK19) en position DC.
- Vérifier si la ligne de base de temps n'a pas bougé de plus de 0,4 div. La correction est possible avec le potentiomètre R126 (R326), Fig. 3.19.
- Commutateur AMPL SK17 (SK18) en position .1 V/div.
- Appliquer une tension rectangulaire de 600 mV_{cc} ±0,5 %, 2 kHz à la douille d'entrée Y_A (Y_B) BU3 (BU5).
- Vérifier si la hauteur de trace est de 6 div ±2 %. La correction est possible avec R111 (R311), Fig. 3.18.
- Appliquer une tension sinusoïdale de 600 mV_{cc} ±0,5 %, 10 MHz à douille d'entrée Y_A (Y_B) BU3 (BU5).
- Vérifier si la hauter de trace est d'au moins 4,2 div.

2.4.4. X VIA Y_A

- Enfoncer BEAM SELECTOR A SK14 et B SK15.
- Mettre le commutateur TIME/div SK2 en position X via Y_A.
- Mettre le commutateur AC-0-DC SK19 en position 0.
- Appliquer une tension rectangulaire de 600 mV_{cc} ±0,5 %, 2 kHz à la douille d'entrée Y_A BU3.
- Vérifier si la largeur de trace est de 6 div ±3 %.
  La correction est possible avec le potentiomètre R601 (Fig. 3.17.).

2.4.5. BASE DE TEMPS

- Vérifier le coefficient de temps en position 20 μs du commutateur TIME/div SK2 à l'aide des marqueurs de temps. Tolérance: ±5 %. La correction est possible avec le potentiomètre R534 (Fig. 3.17.).
- Vérifier les autres coefficients de temps; tolérance ±5 %.

2.4.6. DECLENCHEMENT

- Appliquer une tension sinusoïdale de 100 mV_{cc}, 10 MHz à la douille d'entrée Y_A BU3.
- Vérifier s'il est possible de régler le potentiomètre LEVEL R3 pour représentation stationnaire.

Service manual

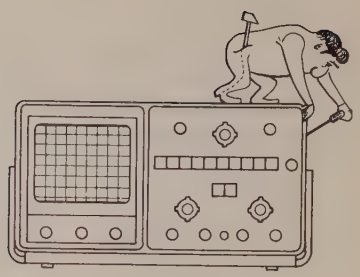
Contents

		Page
3.	SERVICE DATA	71
3.1.	Circuit description	71
3.1.1.	Channel Y_A vertical amplifier	71
3.1.1.1.	General	71
3.1.1.2.	Input coupling	71
3.1.1.3.	Input attenuator	71
3.1.1.4.	Input stage	71
3.1.1.5.	Pre-amplifier	72
3.1.1.6.	Drift-reduction circuit	72
3.1.1.7.	Trigger pick-off stage	74
3.1.1.8.	Delay line circuit	74
3.1.1.9.	Output amplifier	74
3.1.2.	Channel Y_B vertical amplifier	74
3.1.3.	Triggering	74
3.1.3.1.	Trigger pre-amplifier for internal triggering	75
3.1.3.2.	Trigger pre-amplifier for external triggering	75
3.1.3.3.	Long-tailed pair circuit	75
3.1.3.4.	Trigger mode selector	75
3.1.3.5.	Trigger-pulse shaper	75
3.1.4.	Time-base generator	76
3.1.4.1.	Sweep-gating multivibrator and sawtooth generator, single and erase functions	76
3.1.4.2.	Hold-off circuit	77
3.1.4.3.	Auto circuit	77
3.1.5.	Horizontal amplifier	77
3.1.6.	Cathode-ray tube circuitry	78
3.1.6.1.	General information	78
3.1.6.2.	Control circuits	79
3.1.6.3.	Storage unit	80
3.1.6.4.	Write mode	80
3.1.6.5.	Save and Read modes	81
3.1.6.6.	Erase function	81
3.1.6.7.	Erasure in the Write mode	82
3.1.6.8.	Max. Write mode	82
3.1.6.9.	Automatic Brightness Control unit	83
3.1.7.	Power supply	86
3.1.7.1.	Mains transformer	86
3.1.7.2.	Converter and stabilized power supply	86
3.1.8.	Calibration voltage	87
3.2.	Checking and adjusting	88
3.2.1.	General information	88
3.2.2.	Power supply	88
3.2.2.1.	Mains current	88
3.2.2.2.	Supply voltage (R823)	88
3.2.3.	Cathode-ray tube circuit	89
3.2.3.1.	Adjustment to display time-base lines	89
3.2.3.2.	Beam correction	89
3.2.3.3.	Focus and astigmatism (R809, R804)	89
3.2.3.4.	Trace rotation and orthogonality (R813, R834, R838)	90
3.2.3.5.	Barrel and pin-cushion distortion (R812)	90
3.2.3.6.	Brightness (R711, R802, R1138, R1130)	90
3.2.3.7.	Focus correction	91
3.2.3.8.	Flood-current (R844, R846, R847, R848, R849)	91
3.2.3.9.	Backing-electrode G9 (R1059)	91

3.2.3.10.	Collimator G7 (R1051)	91
3.2.3.11.	Background just black (R847, R1044, R1084)	91
3.2.3.12.	Save (R1068)	92
3.2.3.13.	Whistle (R1031)	92
3.2.3.14.	Writing speed (check and calculation)	92
3.2.4.	Vertical amplifiers	93
3.2.4.1.	General information	93
3.2.4.2.	D.C. Balance (R6, R7)	93
3.2.4.3.	Gate current (R126, R326)	93
3.2.4.4.	Pre-amplifier (R64, R99, R264, R299)	93
3.2.4.5.	Sensitivity (R111, R311)	94
3.2.4.6.	Input attenuator	94
3.2.4.7.	Square-wave response (C62, C262, R113, R313, C901, C1001, C902, C1002)	95
3.2.4.8.	Bandwidth of the vertical amplifiers	95
3.2.4.9.	Signal delay equality	95
3.2.4.10.	H.F. Deflection and cross-talk	95
3.2.5.	Triggering	96
3.2.5.1.	Trigger pre-amplifier (R414)	96
3.2.5.2.	Long-tailed pair circuit (R424)	96
3.2.5.3.	Trigger slope	96
3.2.5.4.	Level range with external triggering	96
3.2.5.5.	Level and level range	96
3.2.5.6.	Mains triggering	97
3.2.5.7.	Trigger sensitivity	97
3.2.5.8.	Single-sweep operation	97
3.2.6.	Time-base generator and horizontal amplifier	98
3.2.6.1.	Time coefficients (R534, R539, R618)	98
3.2.6.2.	Magnification and shift (R617)	98
3.2.7.	Mains voltage fluctuations	98
3.2.8.	Beam selection	98
3.2.9.	XY Operation (R601)	99
3.2.10.	Output sockets	99
3.2.10.1.	Calibration voltage on CAL socket BU1 (R761)	99
3.2.10.2.	Time-base voltage on TB OUT socket BU6	99
3.3.	Dismantling the instrument	101
3.3.1.	Warning	101
3.3.2.	Knobs	101
3.3.3.	Bezel	101
3.3.4.	Cabinet plates	101
3.3.5.	Pilot lamp	102
3.3.6.	Text plate of the c.r.t. controls	102
3.3.7.	Storage unit	102
3.3.8.	Time-base unit	102
3.3.9.	Vertical amplifier unit	102
3.3.10.	Main text plate	103
3.3.11.	Cathode-ray tube	104
3.3.12.	Mains transformer	105
3.3.13.	Power supply board	105
3.3.14.	Voltage quadrupler	106
3.3.15.	Replacing a push-button switch	106
3.4.	Information for assistance in fault-finding	107
3.4.1.	Mains transformer data	107
3.4.2.	Voltages and waveforms in the instrument	107
3.4.3.	Remark	107

3.5.	Information concerning accessories	108
3.5.1.	Front cover	108
3.5.2.	Adapter PM 9051	108
3.5.3.	Attenuator probe sets PM 9326 and PM 9327	109
3.5.4.	Attenuator probe sets PM 9336 and PM 9336L	111
3.5.5.	1:1 Probe sets PM 9335 and PM 9335L	113
3.5.6.	2 kV Attenuator probe set PM 9358	115
3.5.7.	Set of eagle clips PM 9333	117
3.5.8.	Multi-purpose camera PM 9380	117
3.5.9.	Adapter PM 9379	118
3.6.	Parts lists and diagrams	120
3.6.1.	Mechanical parts	120
3.6.1.1.	Miscellaneous parts	121
3.6.2.	Electrical parts	123
3.6.2.1.	Capacitors	123
3.6.2.2.	Diodes	124
3.6.2.3.	Integrated circuits	125
3.6.2.4.	Coils	125
3.6.2.5.	Resistors	125
3.6.2.6.	Transistors	129
3.6.3.	Parts list of probe sets	131

3. SERVICE DATA



3.1. Circuit description

3.1.1. CHANNEL Y_A VERTICAL AMPLIFIER

3.1.1.1. General

The vertical amplifier provides control of the input coupling, Y deflection coefficient and gain.
Furthermore, a drift-reduction circuit, a delay line and a trigger pick-off stage are part of the amplifier circuitry.

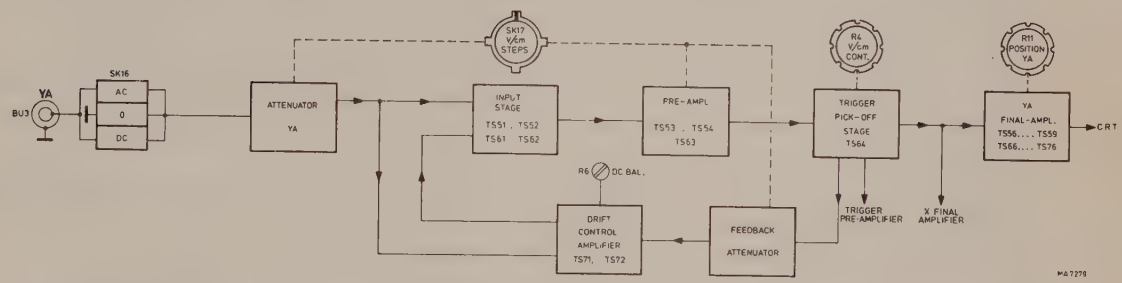


Fig. 3.1. Vertical amplifier, channel Y_A

3.1.1.2. Input coupling

Input signals connected to Y_A socket BU3 can be a.c. coupled, d.c. coupled or internally disconnected.
In position DC of AC-0-DC switch SK16, the input signal is coupled direct to the step attenuator.
In the AC position, there is a capacitor (C26) in the signal path.
This capacitor prevents the d.c. component of the input signal from being applied to the amplifier.
In position 0, the signal path between the input socket and the amplifier input is interrupted, the latter being earthed.
At the same time, blocking capacitor C26 is dischanged via resistor R26, to prevent damage of the circuit under test by a possible high change.

3.1.1.3. Input attenuator

The input attenuator is a frequency-compensated, high-ohmic voltage divider with twelve positions.
Both attenuator sections contain trimmers which are adjusted for optimum square-wave response and others that maintain the same input capacitance (20 pF) for each position of AMPL. switch SK17.
The input capacitance of both channels can be equalized using trimmer C235.
The attenuator works in conjunction with a gain control in the preamplifier (see also section 3.1.1.5.).
The gain of the pre-amplifier is selected together with the relevant attenuator section, by means of AMPL. switch SK17.

3.1.1.4. Input stage

Input source follower TS51 and emitter follower TS52 provide a high input impedance to the step attenuator and a low-impedance source to the pre-amplifier.
The input source-follower is protected by diodes GR53 and GR54
If there is a maximum positive-going voltage change, the field-effect transistor can deal with it. If the change goes negative beyond the threshold established by zener diode GR54, diode GR53 starts conducting and the excess is short-circuit to earth.

The non-driven part of the input stage (TS62) is decoupled for high frequencies, by means of capacitor C59. This part of the input stage receives the d.c. balance voltage and the drift-feedback voltage from the drift-feedback amplifier.

3.1.1.5. Pre-amplifier

The pre-amplifier comprises two amplifier stages, one with series feedback (TS53 & TS63) and one with shunt feedback (TS54). The overall gain of the pre-amplifier is chiefly determined by the ratio of the shunt feedback resistance (R97 & R99) and series-feedback resistance (resistance between the emitters of transistors TS53 and TS63). The latter resistance, and thus the overall gain of the pre-amplifier, can be varied by connecting resistors in parallel to resistor R62. These parallel resistors are selected, together with a section of the input attenuator, by means of AMPL. switch SK17. In this way twelve different deflection coefficients are obtained (see also section 3.1.1.3.).
Potentiometers R64 and R99 are pre-set controls for the gain of the pre-amplifier at different settings of AMPL. switch SK17.

3.1.1.6. Drift-reduction circuit

In the event of no drift phenomena in the pre-amplifier, attenuator R102, R40...R44 provides at junction R128-C67 a voltage which is exactly to, but in anti-phase with, the voltage at the gate of field-effect transistor TS51 (junction R52-R54). This is true because attenuator R102, R40...R44 is switched over together with the gain switch of the pre-amplifier. Junction R128-R53 will then be on earth level (virtual earth point).

When there is a drift phenomenon, junction R128-R52 carries half the drift voltage. This voltage is amplified by transistors TS71 and TS72 and, in the correct phase, applied to field-effect transistor TS62. The resulting feedback grings the output level of the amplifier back to 0 V. The d.c. level of the feedback is adjusted with DC BAL potentiometer R6.

In order to prevent the base currents of transistors TS71 and TS72 from flowing through high-ohmic resistors R128 and R52, they are compensated for by means of potentiometer R126 and resistors R127 and R129. Resistors R131 equalize the base impedances of transistors TS71 and TS72.

Capacitor C59 limits the feedback at approximately 100 Hz.
Therefore, a variation of the value of potentiometers R64 & R99 causes a variation in the top of a l.f. square-wave voltage. When potentiometers R64 and R99 are correctly adjusted, the pulse top is straight.

3.1.1.6.1. Drift reduction

The drift inherent in the sensitive d.c. coupled pre-amplifier is reduced by feedback via a control amplifier. We shall now calculate the effect of the control amplifier with reference to Fig. 3.2. in which A is the gain factor of the pre-amplifier and B that of the control amplifier. Resistors R are equal.

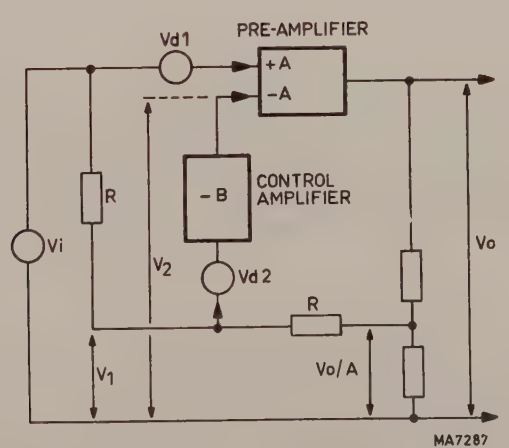


Fig. 3.2. Block diagram of the drift-reduction circuit

We regard the drift voltages from pre-amplifier and control amplifier as being due to d.c. voltage sources at the input (Vd1 and Vd2). We then find:

$$V1 = \frac{Vi + \frac{Vo}{A}}{2} \qquad (1)$$

$$V2 = -B\,(V1 + Vd2) \qquad (2)$$

$$Vo = A\,(V2 - Vi - Vd) \qquad (3)$$

It follows from (1) and (3) that:

$$V1 = \frac{Vi + \frac{A\,(V2 - Vi - Vd1)}{A}}{2} = \frac{V2 - Vd1}{2}$$

Substituting this result in (2) gives:

$$V2 = -B\,(\frac{V2 - Vd1}{2} + Vd2) \qquad \text{or}$$

$$V2\,(1 + \frac{B}{2}) = \frac{B}{2}\,Vd1 - BVd2 \qquad \text{or}$$

$$V2 = \frac{BVd1}{2 + B} - \frac{BVd2}{1 + \frac{B}{2}}$$

Substituting this result in (3) gives:

$$\frac{Vo}{A} = (\frac{B}{2 + B} - 1)\,Vd1 - \frac{BVd2}{1 + \frac{B}{2}} - Vi \qquad \text{or}$$

$$-\frac{Vo}{A} = Vi + \frac{2}{2 + B}\,Vd1 + \frac{B}{1 + \frac{B}{2}}\,Vd2 \qquad \text{or}$$

$$-\frac{Vo}{A} = Vi + \frac{1}{1 + \frac{B}{2}}\,Vd1 + \frac{2}{1 + \frac{2}{B}}\,Vd2$$

The last two terms represent drift voltages which are equivalent to a drift voltage:

$$Vd = \frac{1}{1 + \frac{B}{2}}\,Vd1 + \frac{2}{1 + \frac{2}{B}}\,Vd2$$

at the input.

We see that the drift of the pre-amplifiers is reduced by a factor $(1 + \frac{B}{2})$. On the other hand, we have an extra drift due to the control amplifier, which is given by $\frac{2}{1 + \frac{2}{B}}\,Vd2 \approx 2Vd2$.

The drift of the control amplifier, however, is so low (because of strong thermal coupling of the amplifier transistors, and optimum design) that the term 2Vd2 can be neglected.

3.1.1.7. Trigger pick-off stage

Transistor TS64 serves a twofold purpose. It acts as an amplifier stage for the channel Y_A triggering signal further discussed in section 3.1.3.1., and as an emitter-follower for the signal to be tested.
The test signal is applied to the delay line circuit via AMPL. potentiometer R4 in the emitter circuit of transistor TS64. This potentiometer provides an uncalibrated, continuous control of the deflection coefficients.

3.1.1.8. Delay line circuit

The delay line circuit consists of an assymmetrically driven differential amplifier (TS902 & TS903), which is coupled with emitter followers (TS901, TS904 & TS906) at the input as well at the output.
Emitter follower TS906 serves the symmetry. From resistor R903 in the emitter circuit of transistor TS901 the signal is, via the delay line, applied to the differential amplifier. The delayed test signal is coupled to the output stage via emitter follower TS904, which reduces the effect of the input capacitance of the output stage on the differential amplifier.
The input of the delay line is terminated by R903//R904 and its output by R907.

3.1.1.9. Output amplifier

From the emitter of emitter follower TS904, the signal is applied to the base of transistor TS66 which is part of a differential amplifier. By varying the series feedback of this amplifier by means of potentiometer R111, the overall gain of the Y_A channel can be set. The RC combination R113-C62 corrects the gain factor at high frequencies.

The Y shift voltage derived from POSITION potentiometer R11 is applied to the base of transistor TS67.
If BEAM SELECTOR switch SK14 is not depressed, the voltage on the base of TS67 is such that the trace is shifted off the screen and cannot be brought back with the POSITION potentiometer.

From the differential amplifier the signal is fed to the final stage which consists of two single-ended push-pull sections, viz. TS57, 58, 59, 68 and TS69, 73, 74, 76. From these two sections, the signal is applied to the Y deflection plates.
The circuit with transistor TS56 will be discussed together with the c.r.t. circuitry (section 3.1.6.2.1.).
In position X via Y_a, the signal is fed to the X output amplifier via emitter follower TS75. In this case the channel Y_A output amplifier is inoperative.

3.1.2. CHANNEL Y_B VERTICAL AMPLIFIER

As this channel is identical to channel Y_A with the exception of the circuitry for external X deflection, the description of channel Y_A also holds good for channel Y_B. Components are assigned in the 200-299 range (corresponding to numbers in the 1-99 range for channel Y_A), in the 300-399 range (corresponding to range 100-199 in channel Y_A) and in the 1000-1099 range (corresponding to range 900-999 in channel Y_A).

3.1.3. TRIGGERING

The trigger unit comprises the following circuits:
a trigger pre-amplifier, a differential amplifier, trigger mode selector and a trigger-pulse shaper.
The circuit diagram shows all triggering push-buttons in their released positions.

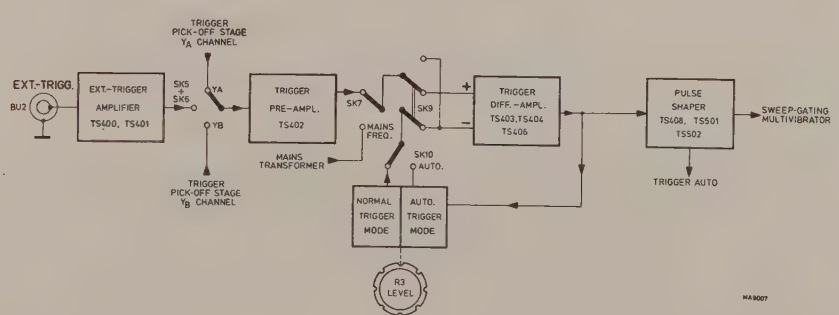


Fig. 3.3. Trigger unit

3.1.3.1. Trigger pre-amplifier for internal triggering

If Y_A push-button SK4 is depressed, trigger pick-off stage TS64 in the Y_A channel and transistor TS402 form together an amplifier with series and shunt feedback. Y_A push-button SK4 is only a mechanical release for Y_B push-button SK5 and is, therefore, not included in the circuit diagram; thus, SK4 depressed corresponds to SK5 released. The gain of trigger pre-amplifier is determined by the ratio of the shunt feedback resistance R412 and the series-feedback resistance in the emitter circuit of transistor TS64.

If Y_B push-button SK5 is depressed, trigger pick-off stage TS264 in the Y_B channel and transistor TS402 form the trigger pre-amplifier.

3.1.3.2. Trigger pre-amplifier for external triggering

If EXT. push-button SK6 is depressed, transistors TS401 and TS402 form together a similar amplifier with series- and shunt-feedback as described in section 3.1.3.1. Transistor 400 serves as an inverter for the triggering signals so that the next stage is driven in the correct phase. Moreover, this transistor improves the stability of the pre-amplifier. The external trigger input is protected against excessive positive input voltages by means of diodes GR401 and GR402.

3.1.3.3. Long-tailed pair circuit (differential amplifier)

The following description applies to internal triggering.
From the pre-amplifier the triggering signal is fed to the long-tailed pair circuit with transistors TS403 and TS404. The signal is applied to the base of transistor TS403 if + push-button SK8 is depressed and to the base of TS404 if — push-button SK9 is depressed.
This allows triggering on either the positive or negative slope of the signal. The + push-button SK8 is a mechanical release for — button SK9 and is, therefore, not included in the circuit diagram.

3.1.3.4. Trigger mode selector

A d.c. voltage which is variable with LEVEL potentiometer R3' is applied to the base of the non-driven transistor of the long-tailed pair circuit (3.1.3.3.).
As a long-tailed pair circuit amplifies the difference of the base voltages, the setting of potentiometer R3' determines which part of the signal will be amplified and, thus, the trigger level.
The output signal of the long-tailed pair circuit is fed to emitter follower TS406. If AUTO push-button SK10 is depressed, the a.c. component of the imetter signal of TS406 is applied to the full-wave rectifier with diodes GR404 and GR406. The rectified voltage across LEVEL potentiometer R3'' corresponds to the peak-to-peak value of the a.c. component of the trigger signal. This d.c. voltage is fed to the base of transistor TS404 of the long-tailed pair circuit. The result is that in the auto mode the trigger level range corresponds to the peak-to-peak value of the triggering signal.

3.1.3.5. Trigger-pulse shaper

The trigger-pulse shaper comprises transistors TS501 & TS502 in Schmitt-trigger configuration. With a repetitive trigger signal, a square-wave voltage of constant amplitude and width arises at the collector of TS502. This square-wave voltage is differentiated by C502 and R514 into narrow positive and negative pulses. The positive pulses are short-circuited by GR501 so that sweep-gating multivibrator TS503-TS504 receives only negative pulses.

3.1.4. TIME-BASE GENERATOR

The time-base generator comprises a sweep-gating multivibrator, a sawtooth generator, a hold-off circuit and an auto circuit.

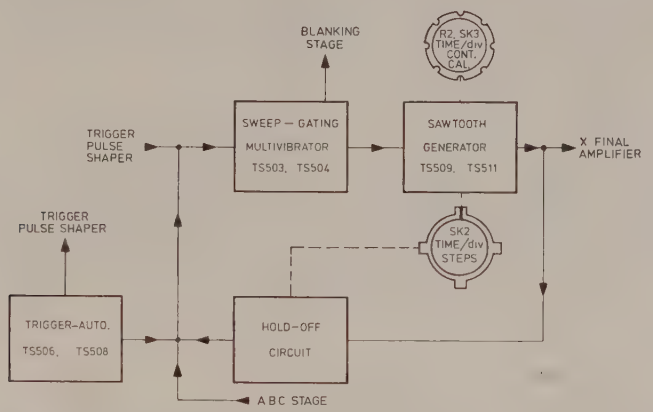


Fig. 3.4. Time-base generator

3.1.4.1. Sweep-gating multivibrator and sawtooth generator, single and erase functions

The sweep-gating multivibrator comprises transistors TS503 and TS504 in Schmitt-trigger configuration.
In the state transistor TS503 cut off and transistor TS504 conducting, transistor TS509 is cut off.
Then the time-base capacitor selected with TIME/div switch SK2 is charged with a constant current supplied by transistor TS511. The rate of voltage increases which determines the sweep time or time coefficient, is inversly proportional to the capacitance of the selected capacitor and direct proportional to the current through transistor TS511. This current is determined by the base voltage of transistor TS511, the voltage of which can be set by the TIME/div vernier control R2 and preset by potentiometers R534 and R539.
The charging current is, moreover, determined by the value of the emitter resistors of transistor TS511, which are also switched over by TIME/div switch SK2.
The sawtooth voltage is taken off by a cascade circuit consisting of emitter followers TS512 and TS513 and applied to both the hold-off circuit and the horizontal amplifier.

Via the hold-off circuit, the sawtooth voltage is fed back to the input of the sweep-gating multivibrator whose input level is preset with stability potentiometer R553. At a certain value of the sawtooth voltage, in the automatic mode, the sweep-gating multivibrator is set to the state transistor TS503 conducting and transistor TS504 cut off. In the other trigger modes (except SINGLE mode) the switching over occurs when the sum of sawtooth voltage and trigger pulses reaches a certain value. Then transistor TS509 starts conducting and the time-base capacitor is discharged via this transistor. This cycle is repeated upon arrival of the next trigger pulse.

In the SINGLE mode a signal coming from flip-flop I.C. 1003 is fed to the input of the sweep-gating multivibrator via diode GR1026. The sum signal has such a level that incoming trigger pulses cannot switch over the multivibrator. Transistor TS503 is in the conducting state, transistor TS504 is cut off and transistor TS509 is conducting
By pressing the RESET button, the sum signal decreases to such a level that the first coming trigger pulse switches over the sweep-gating multivibrator and the sweep runs only once (see Fig. 3.12Simplified circuit diagram).

If the ERASE button has been pressed a signal is fed to the sweep-gating multivibrator via diode GR1027. This signal comprises a d.c. component and a pulse of 0,6 sec. which ensures that the time-base does not start again before the time-base capacitors have been entirely discharged. Due to this signal the sweep-gating multivibrator will be set to the state transistor TS503 conducting, transistor TS504 cut-off and transistor TS509 is conducting. In this position the time-base capacitors are discharged, and the time-base will run again upon arrival of the next trigger pulse (see Fig. 3.12. Simplified circuit diagram).

3.1.4.2. Hold-off circuit

Due to the effect of diode GR504, the charge of the hold-off capacitor selected with TIME/cm switch SK2, cannot follow the decay of the sawtooth voltage.
The capacitor voltage will then decrease with an RC time which is sufficiently large to allow the sawtooth to reach its zero level and to ensure the decay of the switching phenomena. During this RC time, the input level of the sweep-gating multivibrator is so high that incoming trigger pulses have no effect.

3.1.4.3. Auto circuit

The AUTO circuit makes the time-base generator free-running when there are no trigger pulses.
The AUTO circuit works in every trigger mode, except when either AC push-button SK11 or DC push-button SK12 is depressed.

If there are trigger pulses, they are fed to the base of transistor TS506 of the AUTO circuit. As a result of this, the two transistors TS506 and TS508 of the AUTO circuit are conductive until capacitor C506 is discharged. The voltage at the cathode of diode GR502 is then so positive that the latter remains blocked and the working of the sawtooth generator, as described above, is not affected.

As soon as there are no trigger pulses, capacitor C506 will be charged and diode GR502 becomes conductive. The voltage level at the input of the sweep-gating multivibrator TS503-TS504 then drops to such a value that the multivibrator switches over and a sawtooth is formed. This occurs immediately after the drop of the hold-off pulse, i.e., the time-generator is free-running.

3.1.5. HORIZONTAL AMPLIFIER

In the time positions of TIME/div switch SK2 the sawtooth voltage of the time-base generator is fed to the base of transistor TS603. The sawtooth is also applied, for external purposes, to TB OUT socket BU6 via emitter follower TS516.

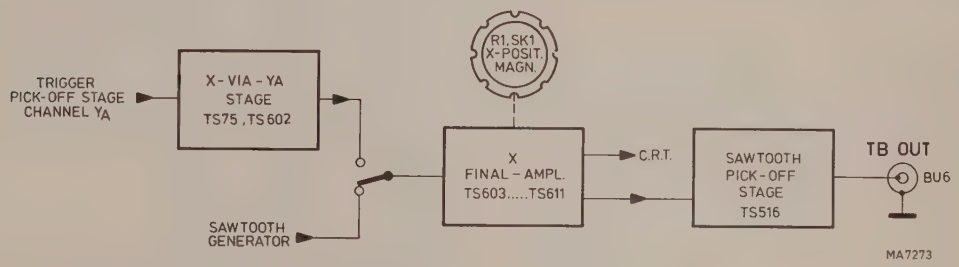


Fig. 3.5. Horizontal amplifier

In position X via Y_A of TIME/div switch SK2, the external X deflection voltage applied to the Y_A channel is fed from transistor TS64 to the base of transistor TS603, via emitter follower TS75 and amplifier TS602.
The external X deflection voltage is also applied to TB OUT socket BU6, via emitter follower TS516.

The horizontal output amplifier comprises two stages.
The first one with transistors TS603 and TS604 is provided with series-feedback.
The second one consists of two single-ended push-pull sections TS607-608 and TS609-611 with shunt-feedback.
From the latter stage the deflection signal is fed to the c.r.t.

The gain of the output amplifier is determined by the shunt-feedback resistors R628 and R633, and the emitter resistance of transistors TS603 and TS604.
X MAGN switch SK1 allows a gain control in two steps.
If switch SK1 is closed (X MAGN knob pullsed out), the series-feedback in the emitter circuit of transistors TS603 and TS604 is decreased in such a way that the gain of the output amplifier is increased by a factor of 5.
In the latter mode, the magnified mode, the gain can be preset by means of potentiometer R617 and in the normal mode by means of potentiometer R618.
In position X via Y_A of TIME/div switch SK2, switch SK1 is bypassed and the output amplifier works in the magnified mode.

The horizontal shift voltage coming from X POSITION potentiometer R1 is supplied to the base of transistor TS604. Transistor TS606 acts as a constant emitter-current source for amplifier stage TS603-TS604.

3.1.6. CATHODE-RAY TUBE CIRCUITRY

3.1.6.1. General information

The CRT circuitry provides the voltage levels, timing pulses and comprises control circuits necessary for storage operation of the cathode-ray tube.

This circuitry consists of the following sections:

- Control circuits for correction and adjusting of astigmatism, trace rotation, orthogonality, flood gun voltages, barrel and pin-cushion distortion and focus.
- Storage unit.
- Automatic brightness control unit.
- Blanking circuit.

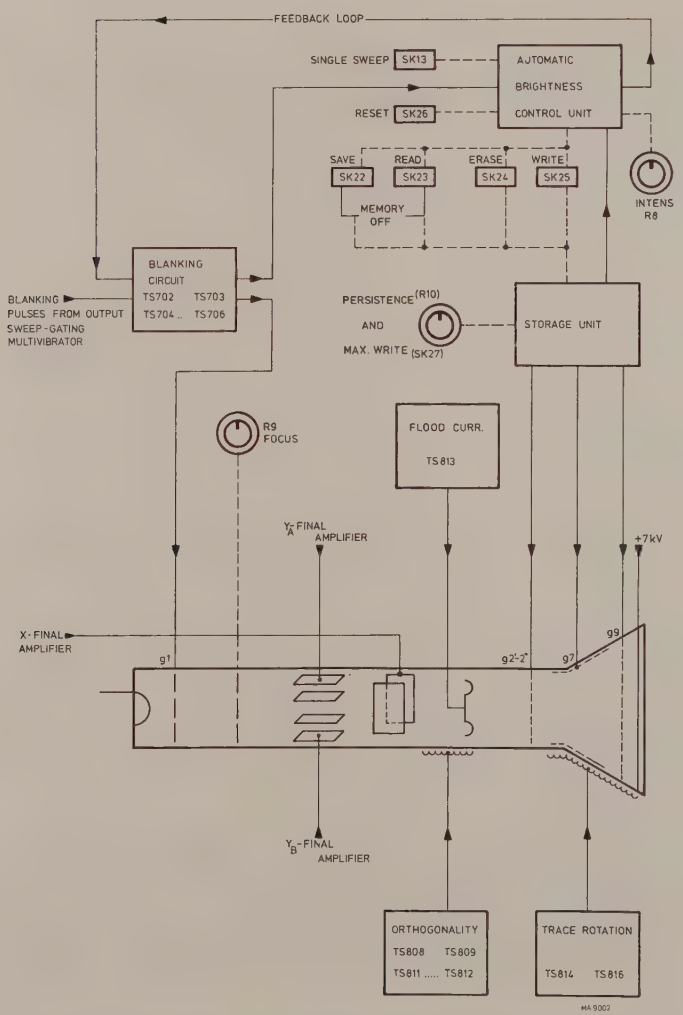


Fig. 3.6. Cathode-ray tube circuitry

3.1.6.2. Control circuits

. Astigmatism is corrected on a low-impedance level by means of potentiometer R809 via emitter follower TS801.

. Trace rotation is achieved by means of the trace rotation coil. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan.
The degree and direction of rotation is determined by setting of potentiometer R813 on the bases of the complementary transistors TS814 and TS816.

. Orthogonality correction is also achieved by means of a coil, which is mounted inside the mu-metal screen. The magnetic field of this coil provides adjustment of the X/Y deflection angle to 90°. The current through this coil is controlled by two complementary pairs of emitter followers (TS808, TS809 and TS811, TS812), the base voltages of which are controlled by potentiometers R834 and R838.

. Flood gun cathode and grid (g1) voltages are controlled on a low-impedance level by emitter follower TS813. By means of potentiometer R847 the balance of both cathode voltages is adjustable. The flood current is controlled by the voltage levels on the grids "g1" and adjustable with potentiometers R848 and R849.

. Barrel and pin-cushion distortion is corrected with the aid of potentiometer R812.

. The display can be focussed by means of FOCUS potentiometer R9. In a spit-beam c.r.t. as used in this oscilloscope, focussing has certain consequences. These consequences and their remedies are discussed in section 3.1.6.2.1.

3.1.6.2.1. Focussing in the split-beam c.r.t.

In the split-beam c.r.t. the electron beam is split into two parts which form the traces of the Y_A and Y_B channel.
Both traces are controlled independently by the controls of both channels. The electron beam is focused, however, before it is split and, therefore, there is only one focus control. This mono-knob control of the focus has the following consequence.
Assume a focus setting as illustrated in Fig. 3.7.a.
Then the focusing point is exactly on the screen.
When the FOCUS potentiometer R9 is rotated, the focusing point is displaced to a point either side of the screen (Figs. 3.7.b. & 3.7.c.). This results in both traces moving away from each other. The more clockwise or anti-clockwise the FOCUS control is turned, the further the traces move apart.

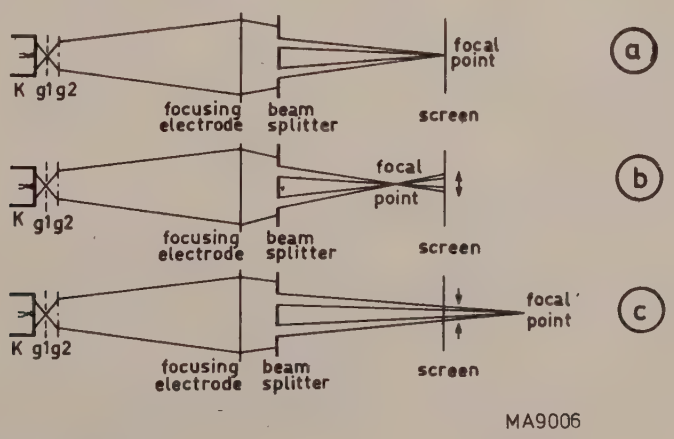


Fig. 3.7. Effect of the focus control

To compensate for this trace shift, an extra shift voltage is fed to the vertical amplifier channels via transistor TS56. The magnitude of this voltage is controlled by potentiometer R9' which is part of FOCUS tandem potentiometer R9. The control is such, that the displacement caused by operation of the FOCUS control is compensated for.
The compensation voltage for channel Y_A is obtained from the emitter of transistor TS56 and that for channel Y_B from the collector.
The compensation is so effective that the maximum displacement of each trace, caused by rotating FOCUS potentiometer R9 from fully anti-clockwise to fully clockwise, does not exceed 2 mm.

3.1.6.3. Storage unit

3.1.6.3.1. General information

The storage circuit, located on the storage unit, supplies voltage levels and timing pulses to control the storage part of the C.R.T. in the SAVE, READ, ERASE and WRITE modes and in the positions PERSISTENCE and MAX. WRITE.
The storage circuit will be discussed with the aid of the simplified diagram of this circuit as shown in Fig. 3.12.
The schematic of this circuit is on the diagram Fig. 3.51. at the rear of the manual.

3.1.6.4. WRITE mode

The WRITE mode is operative after depressing push-button SK25.
Assume that as a result of an ERASE control signal the storage layer (g9) is at a potential below the cut-off level (Fig. 2.9. and 3.10.) and no flood-gun electrons reach the screen. We now activate the writing gun and let the electron beam move over the storage layer surface. Due to the high potential difference between the writing cathode and the storage mesh (approx. 1500 V), the electrons arrive at the storage layer with such an energy (velocity) that secundary emission occurs. Wherever the surface is struck by the electrons, a positive charge will arise. The highest potential that can be attained in this way is +32 V (see Fig. 3.9.) in relation to earth (approx. same potential as the flood gun cathode). At any value above this potential, the flood-gun electrons would be attracted by the storage-layer surface, thus reducing its potential to the original +32 V value. Those areas of the storage-layer surface that have been charged to near +32 V in relation to earth, allow the post-accelerator field to 'reach through' and capture flood-gun electrons.
Thus, the pattern of charge on the storage-layer surface is displayed on the screen.

In the WRITE mode, potentiometer PERSISTENCE may be used to vary display persistence from less than 0,3 sec to more than 1,5 min. This persistence control is attained by using a series of square-wave pulses (Fig. 3.10.) in order to periodically "wipe" the writter signal from the storage layer.
These erasure pulses are obtained by comparing (I.C.1001 4.5.13.) a 2 kHz triangular voltage with the variable d.c. voltage of PERSISTENCE potentiometer R10.
For explanation of the diagrams are 3.1.6.7. "Erasure in the write mode".

The potential of the flood-gun accelerators g'2 and g"2 depends on the selected operating mode (see Fig. 3.8. and oscillogram 19 in the circuit diagram). In the MEMORY OFF (SAVE and READ push-buttons operated simultaneously) and WRITE modes, transistor TS1019 is hard on and the potential of the flood-gun accelerators is continuously +80 V in relation to earth.

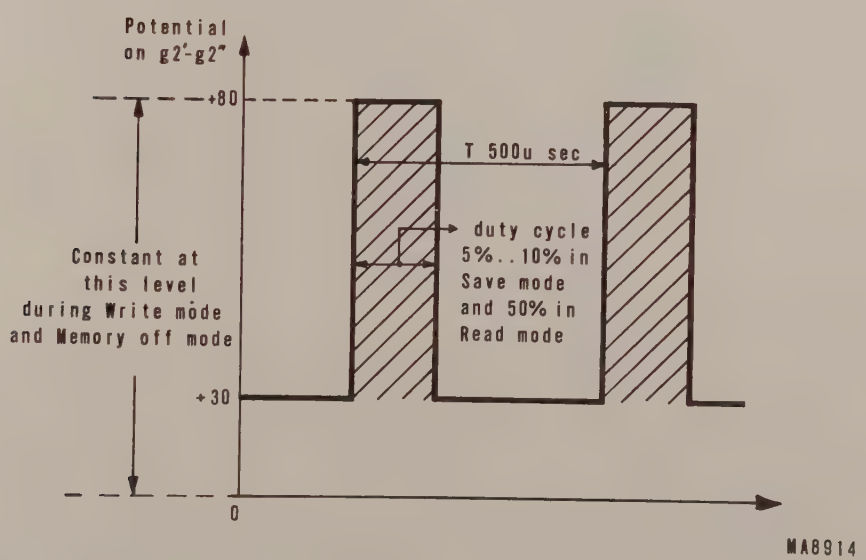


Fig. 3.8. Flood gun accelerators potential during storage mode

3.1.6.5. SAVE and READ modes

If either the SAVE push-button or the READ push-button is depressed, the flood-gun accelerators are supplied with a positively pulsed signal at different duty cycles (see Fig. 3.8.) which determines the display brightness. This pulse signal is obtained by comparing the 2 kHz triangular voltage with fixed (via R1064 and R1067) or variable (via R1068) d.c. voltages. When the READ push-button has been depressed, the duty cycle is 50 %. If push-button SAVE is depressed, the duty cycle is 5 to 10 % (value adjusted by means of preset potentiometer R1068). In this mode, as the duty cycle is low, the flood current will be minimum. Due to this, the brightness is low, and the storage time will be maximum.

3.1.6.6. ERASE function

The stored information can be erased in two different ways:
either manually or automatically. Automatic erasure is possible in the WRITE mode only, the duty cycle being dictated by the setting of the PERSISTENCE potentiometer.

Manual erasure

In the manual erasure mode the potential of the storage mesh (g9) is varied in accordance with the curve shown in Fig. 3.9.a.
The corresponding curve for the storage-layer surface potential is shown in Fig. 3.9.b.
If the ERASE push-button is operated during the period t0-t1, the potential of the storage mesh is equalised to that of the collector mesh (+180 V).

Owing to the capacitive coupling, the storage-layer surface potential rises to almost the same value. As Va is then +180 V in relation to earth, the storage-layer surface is bombarded with flood-electrons of much higher energy level than at first cross-over point (see Fig. 2.4.), which results in a large amount of secundary emission. Therefore, the surface potential becomes strongly positive (+180 V) and all information in the storage layer is overruled. The surface potential cannot increase much beyond +180 V because the collector mesh would then repel the emitted electrons back to the storage surface, tending to decrease its potential.

If the ERASE button is released at moment t1, the potential of the storage mesh drops to +32 V (due to the pulses produces by the circuits "time delay" and the logic circuit I.C.1002) and the storage-layer surface follows suit due to the capacitive coupling.
After 200 ms at moment t2, the storage mesh potential is automatically raised to +38 V in relation to earth. It is held at this value for 400 ms. The storage-layer surface is raised to the same potential due to the capacitive coupling, but then starts capturing flood-gun electrons and the potential decays again towards +32 V in relation to earth.

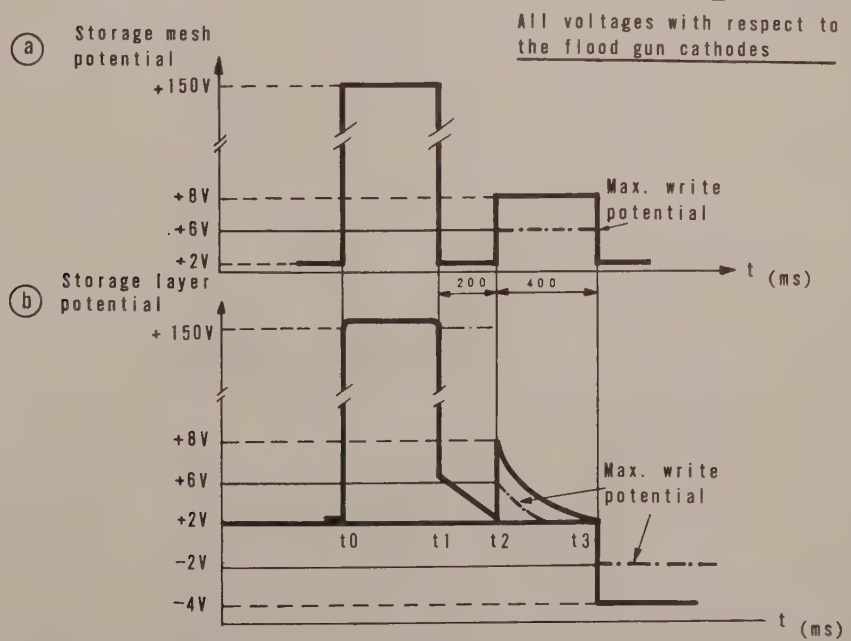


Fig. 3.9. a. Storage-mesh potential during erase cycle
b. Storage-layer surface potential during erase cycle

At the end of the 400 ms at moment t3, the storage mesh potential drops to +32 V. As a result, the potential of the storage-layer surface drops from +32 V to +26 V. The erasure cycle is then complete and the system is in waiting position. During the erasure cycle, there is fed via diode GR1027 a d.c. signal to the hold-off circuit to inhibit initiation of a sweep during erasure. After releasing push-button ERASE a delayed signal of 0,6 sec (via the same diode) ensures the decay of the charge of the time base capacitors to zero level.

3.1.6.7. Erasure in the WRITE mode

In the WRITE mode, the potential of the storage-layer surface is gradually brought back to below the cut-off value by a number of automatic cycles of pulsed erasure (see Fig. 3.10.a.). The erasure signal is a square-wave voltage of approximately 2 kHz supplied by IC1001 and fed to storage mesh g9. This signal and the appertaining potential on the storage-layer surface are shown in Fig. 3.10. (b & c).

As in the manual erasure mode, the storage layer potential follows the voltage changes on the storage mesh. However, during each pulse the storage layer potential becomes positive in relation to the flood-gun electrons. Consequently, the potential drops by an amount of ΔV (see Fig. 3.10.b.). If this process is repeated a number of times, the rest potential on the storage-layer surface will eventually pass the cut-off level and the stored information will be erased. When the pulse width or, in other words, the duty cycle is increased, the drop in layer potential is increased too ($\Delta V'$ in Fig. 3.10.c.) and it takes less time (or pulses) to complete the erasure. The duty cycle of the erasure pulses can be varied between 0 and 30 % (corresponding to 0.3 seconds and 1.5 minutes) by means of PERSISTENCE potentiometer R10.

3.1.6.8. MAX. WRITE mode

The secundary emission of electrons from the storage-layer surface caused by the bombarding flood-gun electrodes must charge the layer from its erased potential of +26 V (all voltages in relation to earth) to the storage threshold (cut-off level) of approximately +29 V, before flood-gun electrons come under the influence of post accelerator g10 (see Fig. 3.9.&3.10.). Therefore, it is obvious that the writing speed of the c.r.t. can be enhanced by erasing the surface to just below the storage threshold, say to +28 V in stead of +26 V. If the instrument is switched to the MAX. WRITE mode, R1081 and R1083 are connected in parallel to R1082 and R1084. As a result of this, the amplitude of the erase pulse between moments t2 and t3 in Fig. 3.9.b. is approximately halved. Consequently, the potential of the storage-layer surface after erasure is approximately +28 V. As the layer potential is raised to almost the threshold potential, a larger part of the electron cloud will reach the phosphor viewing screen, resulting in a light-green background hue. Although the contract is reduced a little, the writing speed for fast single shot signals is increased by a factor of 10.

In the MAX. WRITE mode, also the collimator voltage is adapted to the new circumstances by connecting R1047 and R1048 in parallel to R1052. The erasure signal is always fed to the collimator in order to 'shake' the electron cloud. In this way. an even hue is obtained.

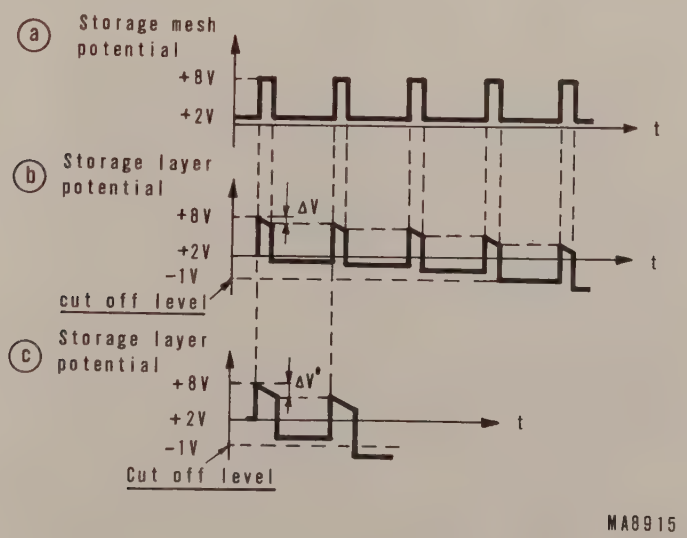


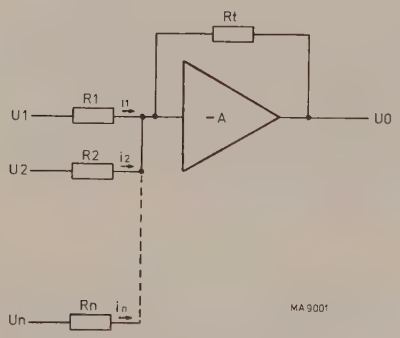
Fig. 3.10. a. Storage-mesh potential during variable persistence mode
b. Corresponding storage-layer surface potential containing information
c. Same as b. but persistence adjustment shorter (bigger pulse width)

3.1.6.9. Automatic brightness control unit

The A.B.C. unit is a circuit which controls the trace brilliance by means of the following devices.

- The ratio between sweep time and combination sweep time/hold-off time (in the following text this ratio will be called duty cycle). If this ratio drops to half, i.e. half the sweep time at the same combination time, the trace brilliance will double so as to give a constant brilliance impression on the screen.
- The INTENS potentiometer which operates on a low voltage level.
- A circuit which realizes as high a trace brilliance as possible in the SINGLE SWEEP mode to obtain the maximum writing speed.
- During erasure, the beam must be suppressed. In the display mode y = f(t), the trace is blanked by a signal from the time-base generator. In the display mode y = f(x), blanking is provided by a special circuit.

The output quantities of the devices are combined in operational amplifier TS1029-TS1031. This operational amplifier is basically the adding circuit shown in Fig. 3.11.



Relation between input and output quantities in an adding circuit is:

$$U_o = R_t (i_1 + i_2 + \ldots\ldots i_n)$$

$$U_o = R_t \left(\frac{U_1}{R_1} + \frac{U_2}{R_2} + \ldots \frac{U_n}{R_n} \right)$$

Fig. 3.11. Operational amplifier

The output voltage of this operational amplifier is used as supply voltage for the Z amplifier (collector voltage of TS704).

Blanking circuit and duty cycle

The blanking circuit blanks the c.r.t. during the fly-back of the time-base generator and unblanks the c.r.t. during the sweep and constantly if TIME/cm switch SK2 occupies position X via Y_A.

The blanking circuit operates on a low voltage level and comprises an a.c. and a d.c. path.

Transistor TS706 is driven by the collector signal of transistor TS504 in the sweep-gating multivibrator. Transistor TS706 forms together with transistor TS704 a single-ended push-pull circuit. The gain factor of this amplifier is such that even when the collector voltage of TS704 is maximum, the Z signal is limited to this voltage. In other words, the amplitude of the Z signal is determined by the output voltage of operational amplifier TS1029-TS1031.

- A.C. PATH : The amplified a.c. components of the blanking signal are fed direct to the Wehnelt cylinder of the c.r.t. via H.T. capacitor C707.
- D.C. PATH : For the d.c. component of the blanking signal, the signal of oscillator TS702-TS703 is used. The oscillator signal is modulated with the blanking signal. The amplified modulated signal on the collector of transistor TS703 is via capacitor C706 fed to demodulator GR702-R713. After demodulation, also the d.c. component of the blanking signal is available.

The a.c. and d.c. amplifications are equalized by means of potentiometer R711.

The Z signal (diagram 11 or Fig. 3.51.) is fed to electronic switch TS1026 via resistor R1124. The switch either blocks the Z signal or transmits it to resistor R1131 and C1027. Resistor R1131 forms together with resistor R1124 a 1:10 voltage divider, and together with capacitor C1027 an integrator. Thus, if the switch is closed the Z signal is attenuated by a factor of ten and integrated. Via emitter follower TS1028, this signal is applied to the input of operational amplifier TS1029-TS1031. In this way, a closed loop is obtained. The other output quantities of the a.b.c. unit are also used as input signals for this loop. In the loop, the mean value of the Z signal is fed back to the blanking stage with transistors TS702, 703, 704 and 706. If the loop gain were very large, the mean value would be constant owing to the feedback. A constant mean value means: half the amplitude when the pulse width is doubled.

The loop gain, however, is low (≈ 4) and, therefore, the duty cycle is not inversely proportional to the amplitude of the Z signal. The relationship between the Z signal on the Wehnelt cylinder and the beam current (intensity) to the screen of the c.r.t. is not linear either, because of the curved c.r.t. characteristic. Both types of non-ideal behaviour together result, however, in an inversely proportional relationship between beam current and duty cycle.

In the lower sweep speed positions of the time-base generator, the period time of the Z signal is long. To be able to integrate these signals well the time constant of the integrator must be large, i.e. several seconds. There is also the requirement that the system must be able to react fairly quickly: well within one second, in the fater sweep speed positions. Both requirements are incompatible. Therefore, a small time constant is used in this oscilloscope, whereas in the slower sweep-speed positions the feedback loop is interrupted by the electronic switch. Emitter follower TS1028 is then set to a constant d.c. level.

Working of the electronic switch

In the slower sweep-speed positions (1...10 of switch SK2) the switching signal is +12 V. This results in a +1,7 V base voltage of transistor TS1026. This transistor is then conductive so its emitter voltage is +1 V. Diode GR1039 is cut off and GR1038 is conductive. Therefore, the emitter voltage of TS1027 is approx. 0,3 V and this transistor is cut off. Since transistor TS1026 is conductive and transistor TS1027 cut off, the anode voltage of diode GR1037 is lower than its cathode voltage and this diode is cut off. The base voltage of emitter follower TS1028 is then determined by resistors R1129 and R1131 (constant d.c. level). Diode GR1036 prevents transistor TS1026 from bottoming which would impede the proper switching behaviour of this transistor (bottoming occurs when the base voltage exceeds the collector voltage).

In the faster sweep speed positions 11 and onwards of switch SK2 the switching signal is −12 V. Therefore, transistor TS1026 is cut off since its base voltage is −0,6 V and its emitter voltage cannot drop below −0,6 V because of diode GR1039. Diode GR1038 is cut off and transistor TS1027 is conductive. Also diode GR1037 is conductive and the Z signal can reach the integrator via resistor R1124.

Unblanking in the single-sweep mode

In the single sweep mode, the signal for the Z control must be able to reach maximum amplitude, i.e. the output voltage U_o of operational amplifier TS1029-TS1031 must be maximum. To this end, current must be drained from the summation point . The d.c. level at the input of the operational amplifier is +12,6 V. This means that there will be a current drain from the amplifier input to earth via resistors R1107 and R1112, when SINGLE SWEEP switch SK13 is closed.

The maximum Z pulse in single sweep position is only allowed in the y = f(t) mode and not in the y = f(x) mode. In the latter case, switch SK1 in position X via Y_A, junction R1107-R1112 is connected to a voltage of approx. +12 V via diodes GR1028 and GR1031. Therefore, the current through resistors R1107 and R1112 is virtually zero and there cannot be an enlarged Z signal.

Blanking and unblanking in WRITE, READ, SAVE and MEMORY-OFF mode

The four functions WRITE, READ, SAVE and MEMORY-OFF are selected by means of switches SK22, SK23 and SK25. The Z signal must only be present in positions MEMORY-OFF and WRITE. In the two latter positions a switch in series with resistor R1116 is interrupted. The current flowing through R1116 to the summation point then becomes zero. As a result of this, output voltage U_o of operational amplifier TS1029-TS1031 is able to raise and the Z signal is not zero any longer.

Blanking in the erase mode

In position X via Y_A of switch SK2, the y = f(x) mode, a logic '1' is applied to input 12 of NAND IC1003, via diodes GR1028 and GR1029. If at the same time a logic '1' is applied to the other input, point 13 of IC1003, via ERASE switch SK24, the logic output on 11-IC1003 will be '0'. Then R1114 is connected to +20 V and a current flows to the summation point of operation amplifier TS1029-TS1031. The output voltage U_o of the operational amplifier then drops to such a value that the Z signal becomes zero.

In the other positions of SK2, one of the inputs of IC1003 is always logic '0' regardless the level on the other input. The output on point 11 is then always '1', switch TS1023 is opened and no current flows through resistor R1114.

Intens potentiometer

The magnitude of the Z signal may be varied by changing the current to the input of operational amplifier TS1029-TS1031. Continuous control of the brightness is obtained by varying the current through R1137 with the aid of potentiometer R8. With preset potentiometer R1138, the maximum brightness is set.

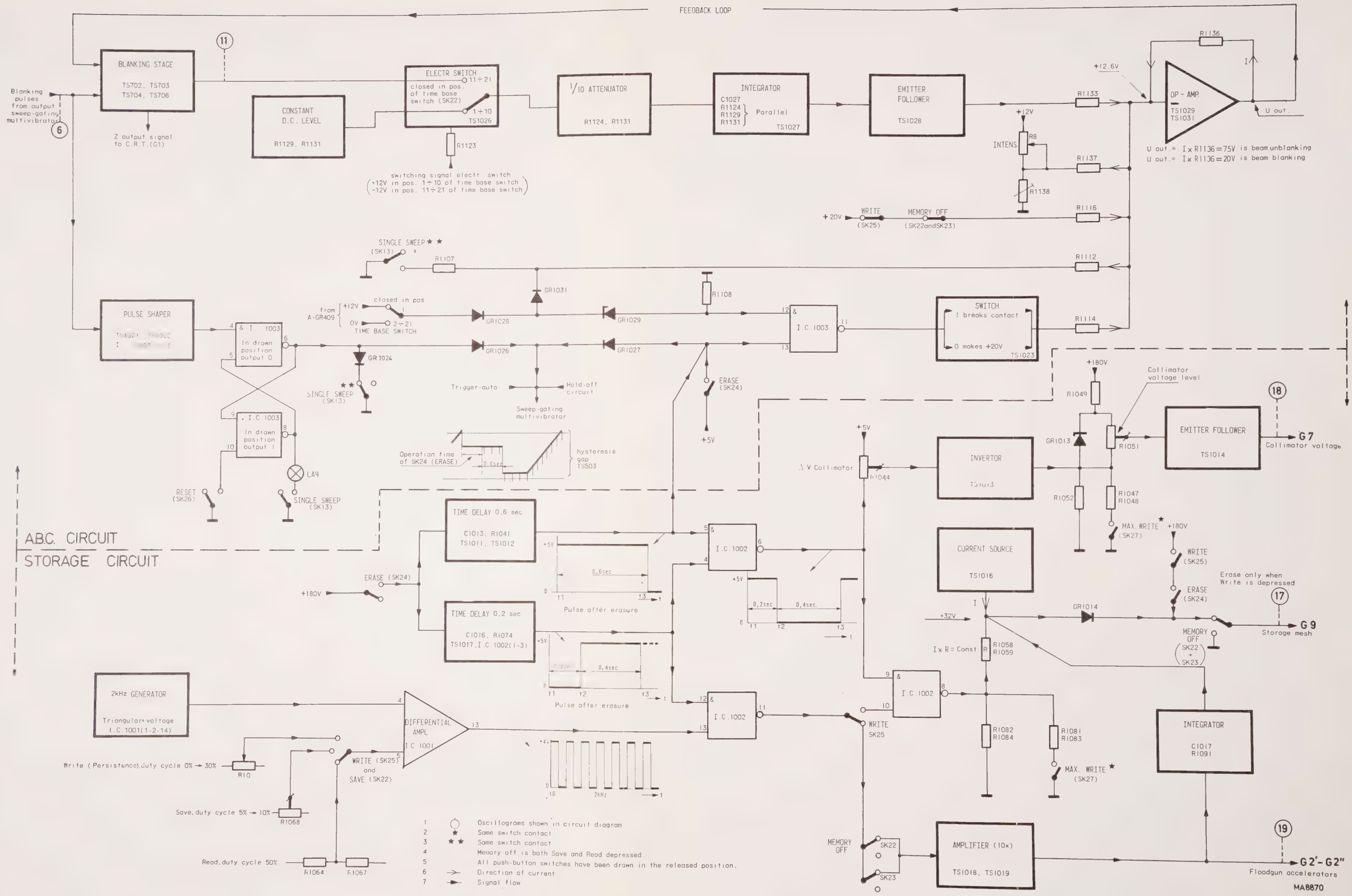


Fig. 3.12. Simplified circuit diagram of ABC stage and storage unit

3.1.7. POWER SUPPLY

The power supply comprises the mains transformer, a full-wave rectifier, stabilized power supply and converter.

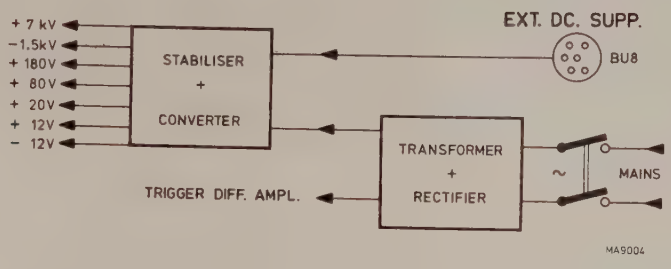


Fig. 3.13. Power supply

3.1.7.1. Mains transformer

Mains transformer TS801 has three primary windings (S1, S1' and S1'') which, together with the secondary winding (S2), can be combined by means of voltage adapter SK21. This combination allows the instrument to be used with mains voltages of 110 V, 127 V, 220 V and 240 V.

The voltage on secondary winding is full-wave rectified. The resulting negative d.c. voltage, or alternatively a negative d.c. voltage on EXT DC SUPPLY input socket BU8, is applied to the voltage stabilizer and converter.

Part of the a.c. voltage on secondary winding of the mains transformer is fed to MAINS trigger source switch SK7, to enable internal triggering on the mains frequency.

3.1.7.2. Converter and stabilized power supply

The converter is a regenerative square-wave generator operating at a frequency of approx. 18 kHz.
A basic diagram of the converter is shown in Fig. 3.14.

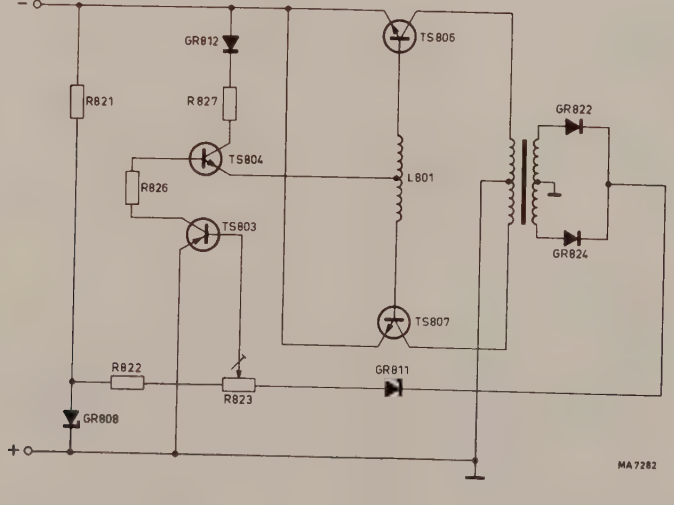


Fig. 3.14. Basic diagram of the converter

In the converter, transistors TS806 and TS807 function as switches and regulators and alternately connect the negative supply voltage to either end of the primary of L801/802. Assume that transistor TS806 has a slightly higher current gain than TS807. Then the positive voltage from the feedback winding quickly drives transistor TS806 into saturation. The current in the top half of the primary of L801/802 increases linearly at a rate determined by the inductance in the primary. This current increase continues until the iron in transformer coil L801 is saturated.
Then the magnetic lines of flux stop changing and consequently no voltage is induced any longer in the feedback winding. When its base drive ceases, transistor is cut off. This reverses the polarity of the feedback voltage and transistor TS807 is turned hard on. The bottom half of the primary then passes an increasing current until the core is saturated in the opposite direction. The subsequent absence of feedback voltage initiates the switching back to TS806 and the cycle starts again.

The regulation works as follows. When an input voltage is applied to the converter, the negative voltage across Zener diode GR808 turns transistor TS803 fully on, as there is no positive voltage from Zener diode GR811.

Then a bias current starts flowing from earth via transistor TS803 through resistor R826, through the base-emitter junction of transistor TS804 (operating as a diode since diode GR812 interrupts the collector circuit) and from base to emitter of both transistors TS806 and TS807.
As there is then an a.c. voltage across the secondary of L801/802, diodes GR822 and GR824 produce a positive d.c. voltage. This voltage reduces the current through transistors TS803 and TS804 sufficiently to limit the drive to transistors TS806 and TS807 and produce the desired output level. The setting of potentiometer R823 determines the value of the regulated output voltage. Possible differences from the set output voltage are fed back via Zener diode GR811 to transistor TS803 so that the drive of transistors TS806 and TS807 is adapted so as to compensate for the differences. This also applies to mains voltage fluctuations.

After rectifying the secondary voltages +12 V (reference), −12 V, +20 V, +80 V, +180 V, −1500 V and high voltage +7000 V are obtained. The voltage quadrupler which supplies the +7000 V cannot be repaired and must be replaced when it breaks down.

All supply voltage except the +7000 V and the −1500 V can be continuously short-circuited without damage to the components. Resistor R827 limits the maximum base current drive to transistors TS806 and TS807 and thus the maximum power output which can be drawn from the converter.
Resistor R826 limits the collector current when the output is short-circuited and the switching action is stopped, thereby holding the dissipated power in transistors TS806 and TS807 at a safe level. Thus, the power supply of the oscilloscope is fully protected against short-circuits. A short-circuit is indicated either by a squeeking noise coming from the power supply or by the pilot lamp failing to light up.

3.1.8. CALIBRATION VOLTAGE

The calibration voltage generator consists of free-running multivibrator TS750 & TS751. The generator frequency is approximately 2 kHz. The amplitude of the generated square-wave voltage is kept at a constant value by means of zener diode GR751. The exact value of the calibration is set with the aid of potentiometer R761.

600mV

3.2. Checking and adjusting

3.2.1. GENERAL INFORMATION

All adjusting elements have been listed in the heading of the various sections.
The tolerances mentioned in the following text apply to newly adjusted instruments only. The values may differ from those given in chapter 1.2. CHARACTERISTICS.
Unless otherwise stated the controls always occupy the same position as the previous check.

3.2.2. POWER SUPPLY

3.2.2.1. Mains current

- Check that the mains voltage adapter (SK21) has been set to 220 V and connect the instrument to such a voltage (frequency 50 Hz)
- Switch the oscilloscope on and check that the pilot lamp lights up
- Check that the current consumption does not exceed 300 mA (measured with a moving-iron meter)

3.2.2.2. Supply voltages (R823)

- Check that the voltage across capacitor C833 is +12 V, + or −20 mV; if necessary, readjust potentiometer R823 (Fig. 3.15.).
- Check the supply voltages in accordance with the following table:

Voltage across	Required value	Max. allowable ripple
C833 (Fig. 3.15)	+ 12 V, ± 30 mV	4 mV_{p-p}
C836 (Fig. 3.15)	− 12 V, ±400 mV	6 mV_{p-p}
C831 (Fig. 3.15)	+ 20 V, ±900 mV	40 mV_{p-p}
C829 (Fig. 3.15)	+ 80 V, ± 2 V	250 mV_{p-p}
C828 (Fig. 3.15)	+180 V, ± 3 V	100 mV_{p-p}

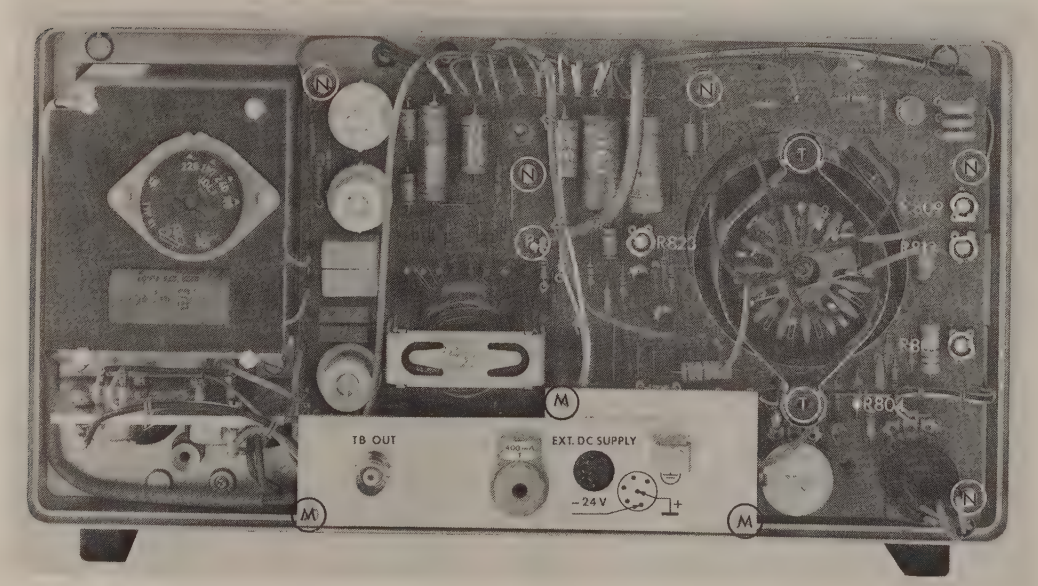


Fig. 3.15. Adjusting and dismantling

- Vary the a.c. voltage to which the instrument is connected between 198 V and 242 V.
- Check that the supply voltages do not vary more than 0.5 % and that the ripple voltages do not exceed the values mentioned in the table above.

3.2.3. CATHODE-RAY- TUBE CIRCUIT

3.2.3.1. Adjustment to display time-base lines

> **CAUTION:** Use minimum beam intensity to produce a clear, well-defined display. Extended high intensity may damage the C.R.T.

3.2.3.1.1. Intensity (R801) and time-base stability (R553)

– Turn INTENS potentiometer R8 anti-clockwise.

1500 V: Use an insulated screw-driver

– Set potentiometer R801 (Fig. 3.15.) to its mid-position and potentiometer R553 (Fig. 3.17.) anti-clockwise.
– Depress buttons SAVE SK22 and READ SK23 simultaneously.
– Set X POSITION potentiometer R1 to its mid-position and depress MAGN switch SK1.
– Set the POSITION potentiometers R11 and R12 to their mid-positions.
– Set TIME/div switch SK2 to 1 ms.
– Depress BEAM SELECTOR switches A SK14 and B SK15.
– Set AMPL switch SK17 and SK18 to .2 V/div.
– Turn INTENS potentiometer R8 for a well-defined display, there should be a display of two time-base lines.
– If both traces are not equally bright, see point 3.2.3.2. "Beam correction".
– See for adjusting with component R801 point 3.2.3.6.

3.2.3.1.2. Time-base stability (R553)

– Depress Y_A switch SK4, + switch SK8, AC switch SK11 and BEAM SELECTOR switch A SK14.
– Turn potentiometer R553 (Fig. 3.17.) clockwise until the time-base line disappears.
– Depress AUTO switch SK10. A time-base line must become visible. If necessary, readjust potentiometer R553.

3.2.3.2. Beam correction (with the magnets)

– Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
– Set AC-0-DC switches SK16 and SK19 to 0.
– Position the traces symmetrically around the centre of the screen using POSITION potentiometers R11 and R12.
– Adjust INTENS potentiometer R8 for a low brightness.
– Check that both traces are equally bright. If necessary, turn screw T (Fig. 2.1.) or rotate magnet T (Fig. 3.15) until both traces have the same brightness.

3.2.3.3. Focus and astigmatism (R809, R804)

– Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
– Push simultaneously SK22 and SK23 to obtain the MEMORY OFF mode.
– Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer to CAL.
– Set AMPL switches SK17 and SK18 to .1 V and AMPL potentiometers R4 and R5 to CAL.
– Set INTENS potentiometer R8 for a low brightness.
– Set AC-0-DC switches SK16 and SK19 to DC.
– Apply a sine-wave signal of 400 mV_{p-p}, 2 kHz, to Y_A input socket BU3 and Y_B input socket BU5.

Use an insulated screw-driver

– Adjust FOCUS potentiometer R9 and astigmatism potentiometer R809 (Fig. 3.15.) for sharp, well-defined traces. Find the setting that gives the best result for both channels.
– Set FOCUS potentiometer R9 in mid-stroke position and check for sharp traces. If necessary select a different value for R804 (Fig. 3.15.).

3.2.3.4. Trace rotation and orthogonality (R813, R834, R838)

- Depress WRITE button SK25.
- Turn the PERSISTENCE potentiometer R10 entirely anti-clockwise.
- Depress BEAM SELECTOR switch B SK15.
- Set INTENS potentiometer R8 for a low brightness.
- Push ERASE button SK24.
- Set TIME/div switch SK2 to X via Y_a.
- Set AMPL switches SK17 and SK18 to .2 V/div and AMPL potentiometer R4 and R5 to CAL.
- Apply a sine-wave signal of 1 kHz with amplitude of 4 V to inputs Y_A (BU3) and Y_B (BU5).
- Set AC-0-DC switch SK16 to AC.
- Set AC-0-DC switch SK19 to 0.
- Centre the time-base line by means of POSITION potentiometer R12.
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule. If necessary, readjust trace rotation potentiometer R813 (Fig. 3.16.).
- Set AC-0-DC switch SK16 to 0.
- Set AC-0-DC switch SK19 to AC.
- Centre the displayed line by means of X-POSITION potentiometer R1.
- Check that the displayed line runs exactly in parallel with the vertical lines of the graticule. If necessary, readjust orthogonality potentiometer R834 or R838 (Fig. 3.16.).

3.2.3.5. Barrel & pin cushion distortion (R812)

- Shift with the aid of X-POSITION potentiometer R1 the displayed vertical line (see point 3.2.3.4.) to the left- and right-hand side of the screen.

  Use an insulated screw-driver. Be careful not to make any short-circuits.

- Check that the displayed line is straight and vertical in both positions.
  A small deviation may occur. If necessary, adjust and determine an average setting with the aid of potentiometer R812 (Fig. 3.15.).
- For optimum adjustment, repeat both checks 3.2.3.4. and 3.2.3.5.
- Set TIME/div switch SK2 to 2 μs/div.
- Shift with POSITION potentiometer R11 the displayed horizontal line to the upper and lower side of the screen.
- Check that the displayed line is straight; adjustable with potentiometer R812.
  If this adjustment was necessary, repeat both procedures 3.2.3.4. and 3.2.3.5.

3.2.3.6. Brightness (R801, R711, R1138, R1130)

1500 V: Use an insulated screw-driver

- Switch the instrument on at least 15 minutes before starting this check.
- Depress Y_A switch SK4, + switch SK8 and BEAM SELECTOR switches A (SK14) and B (SK15).
- Set AC-0-DC switches SK16 and SK19 to 0.
- Depress AC switch SK11 and release SINGLE switch SK13.
- Set TIME/div switch SK2 to 10 ms and TIME/div and potentiometer R2 to CAL.
- Depress WRITE switch SK25.
- Rotate potentiometer PERSISTENCE R10 to its first clockwise stop.
- Turn INTENS potentiometer R8 entirely clockwise.
- Shift the display on to the centre of the screen with the aid of POSITION potentiometers R11 and R12.
- Adjust with FOCUS potentiometer R9 the display, if necessary, adjust the magnets (see point 3.2.3.2.) for equal intensity of both spots.
- The spots must be barely visible; if necessary, readjust potentiometer R801 (Fig. 3.15.). IN REAR
- During this check keep pressing ERASE button SK24 continuously.
- Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
- Push simultaneously SAVE switch (SK22) and READ switch (SK23) to obtain the MEMORY OFF mode of operation.
- Depress AUTO switch SK10.
- Set INTENS potentiometer R8 for minimum brightness.
- Check that the time-base line shows a constant brightness over the entire length; if necessary, readjust potentiometer R711 (Fig. 3.17.).

– For optimum adjustment repeat the above check.
– Switch the instrument off; disconnect wire of floodgun electrodes.
– Insert (well-insulated) a μA-meter between G10 and socket high tension wire, switch the instrument on.
– Turn INTENS potentiometer R8 entirely clockwise.
– Centre the displayed time-base lines by means of X-POSITION potentiometer R1 in such a way, that the indication of the μA-meter is maximum.
– Turn INTENS potentiometer R8 entirely anti-clockwise.
– Measure the dark current (i = x μA).
– Adjust R1138 (Fig. 3.17.) to obtain a reading on the meter of 1 μA + x μA.
– Set TIME/div switch SK2 to .5 ms/div.
– Adjust R1130 (Fig. 3.17.) to obtain a reading on the meter of 1 μA + x μA.
– Switch instrument off, remove μA meter, connect wire of floodgun electrodes and switch instrument on.

3.2.3.7. Focus correction

– Depress buttons SAVE SK22 and READ SK23 simultaneously.
– Depress AUTO switch SK10 and BEAM SELECTOR switches A SK14 and B SK15.
– Set AC-0-DC switches SK16 and SK19 to 0.
– Set the INTENS potentiometer R8 to low brightness.
– Set AMPL switches SK17 and SK18 to .5 V/div and AMPL potentiometers R4 and R5 to CAL.
– Shift the time-base lines on to the horizontal central graticule line with the aid of POSITION potentiometers R11 and R12.
– Rotate FOCUS potentiometer R9 from fully anti-clockwise to fully clockwise and check that this does not cause the time-base lines to shift more than 0,2 div.

3.2.3.8. Flood-current (R844, R846, R847, R848, R849)

– Switch the instrument on at least 15 minutes before starting this check.
– Depress WRITE switch SK25.
– Set INTENS potentiometer R8 for minimum brightness.
– Set R847 (Fig. 3.19.) to its mid-position.
– Connect (floating) a DC mV-meter across R846 and adjust R848 (Fig. 3.19.) to obtain a reading on the meter between 40 and 41 mV.
– Connect the mV-meter across R844 and adjust R849 (Fig. 3.19.) to obtain a reading on the meter between 40 and 41 mV.

3.2.3.9. Backing-electrode G9 (R1059)

– Depress WRITE switch SK25.
– Adjust potentiometer INTENS R8 for minimum brightness.
– Rotate potentiometer PERSISTENCE R10 to its first clockwise stop.
– Connect a DC voltmeter between G9 (+) and cathode K' (–).
– Adjust R1059 (Fig. 3.19.) to obtain a 2 V (±100 mV) reading on the meter.

3.2.3.10. Collimator G7 (R1051)

– Turn R10 PERSISTENCE entirely counter-clockwise.
– Push SK25 WRITE.
– Adjust R1051 (Fig. 3.19.) until the contour-distortions are outside the measuring graticule.

3.2.3.11. Background just black (R847, R1044, R1084) and Max. Write (R1044, R1048, R1083)

– Rotate potentiometer PERSISTENCE R10 to its first clockwise stop.
– Turn potentiometer R1044 (Fig. 3.19.) entirely anti-clockwise.
– Carry out the following adjustments on repetitive operation of the ERASE button SK24.
– Adjust R1084 (Fig. 3.19.) to obtain two barely visible clouds on the screen.
– Adjust R847 (Fig. 3.19.) for equal intensity of the clouds.
– Adjust R1084 (Fig. 3.19.) so, that the background of the screen is just black.

– Carry out the following adjustments on repetitive operation of the ERASE button SK24.
– Turn potentiometer PERSISTENCE R10 to its second clockwise stop.
– Adjust the combination of potentiometers (Fig. 3.19.) R1083, R1044 and R1048 to obtain equal cloud distribution.

– Proceed as follows:
– Turn potentiometers R1048 and R1083 entirely clockwise.
– Turn potentiometer R1083 anti-clockwise so that two clouds are visible on the screen.
– Turn potentiometer R1048 slightly anti-clockwise; stop before the bright-green edges of the clouds are visible on the screen.
– Turn potentiometer R1044 clockwise so that both clouds reach as much screen surface as possible and obtain equal cloud distribution.
– Repeat above procedure, for optimum results, combined, if necessary, with writing-speed check dealt with in point 3.2.3.14.

3.2.3.12. Save (R1068)

– Depress SAVE switch SK22.
– The intensity of a saved signal is adjustable with R1068 (Fig. 3.19.).
– The normal position of R1068 is such that the square-wave voltage at G2' and G2" shows 10 % duty cycle (±10 %).

3.2.3.13. Whistle (R1031)

– Turn potentiometer PERSISTENCE entirely anti-clockwise.
– It may happen that the meshes inside the CRT come into resonance with the square-wave voltages applied to them (about 2 kHz). This can be tuned out by a slight readjustment of R1031 (Fig. 3.19.).

3.2.3.14. Writing speed (writing and calculation)

Definition: The writing speed is the maximum speed of the electron in X- or Y-direction on the screen in single-shot mode at which the written line is visible.
The lines of the pictures obtained must be clearly visible in the WRITE mode as well as in MAX. WRITE mode.
Some divisions at the edge of the screen may be partly written or not at all (the written surface of the screen must be as symmetrical as possible).
The number of non-written divisions may not be more than 16 namely 20 % of the total 8x10=80 divisions of the measuring graticule.

Note: Before this check, the sensitivity of the vertical amplifiers must be adjusted (see point 3.2.4.5. SENSITIVITY).

– Set TIME/div switch SK2 to 2 ms/div and potentiometer TIME/div R2 to CAL.
– Turn INTENS potentiometer R8 entirely clockwise.
– Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
– Depress AUTO switch SK10.
– Depress WRITE switch SK25.
– Set AMPL switches SK17 and SK18 to 50 mV/div and AMPL potentiometers R4 and R5 to CAL.
– Apply a sine-wave signal of 1,6 $V_{p\text{-}p}$, 1 kHz, to Y_A input socket BU3 (a picture height of 32 divisions should be obtained).
– Set the POSITION potentiometers R11 and R12 to their mid-positions.
– Set AC-0-DC switches SK16 and SK19 to AC.
– Depress BEAM SELECTOR switch SK14, BEAM SELECTOR switch SK15 in released position.
– Depress SINGLE switch SK13.
– Turn potentiometer PERSISTENCE R10 to its first clockwise stop.
– Push ERASE button SK24 shortly.
– Push RESET button SK26.
– The sweep runs only once. Push the ERASE and RESET buttons; meanwhile focus with potentiometer R9 the picture obtained.
– Apply the input voltage from the Y_A input socket BU3 to Y_B socket BU5.
– Depress Y_B switch SK5.
– Depress BEAM SELECTOR switch SK15, BEAM SELECTOR switch SK14 in released position.
– Push ERASE button SK24 shortly.
– Push RESET button SK26.
– The sweep runs only once. Push the ERASE and RESET buttons; meanwhile focus with potentiometer R9 the picture obtained.

– For both channels the focus has been adjusted for a maximum, and thus the maximum writing speed.
– Push ERASE button SK24 shortly.
– Push RESET button SK26.
– Check with the aid of a viewing hood that the display covers over 80 % of the measuring graticule.

For checking in MAX. WRITE mode the operation is the same but:
– Turn potentiometer PERSISTENCE R10 to its second clockwise stop.
– Frequency of the input signal 10 kHz.
– Set TIME/div switch SK2 to .2 ms/div.

Calculation: The vertical deflection is 32 divisions as mentioned above.
The path described by the electron beam is then 16 div. $\sin\omega t$ (ω being the circle frequency of the input signal).
The speed of the beam in the vertical direction is thus 16 $\omega\cos\omega t$ (the speed in horizontal direction is negligible).
For the visible part of the sine wave, $\cos\omega t = 1$ may be assumed.
The wiring speed is now (in Norm. writing mode):
$16.2\,\pi \,.\, 10^3$ div./s = 100 div./ms.

3.2.4. VERTICAL AMPLIFIERS

3.2.4.1. General information

– The adjustments of the vertical amplifier channels Y_A and Y_B are identical. The knobs, sockets and adjusting elements of channel Y_B are shown in brackets after those of channel Y_A.
– Unless otherwise stated the controls always occupy the same position as in the previous check.
– Adjust INTENS control R8 for adequate display brightness.

3.2.4.2. D.C. Balance (R6, R7)

– Depress WRITE switch SK25.
– Rotate potentiometer PERSISTENCE R10 entirely anti-clockwise.
– Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
– Set AC-0-DC switch SK16 (SK19) to 0.
– Set AMPL potentiometer R4 (R5) to CAL.
– Check that the trace does not shift if AMPL switch SK17 (SK18) is switched from .1 V/div to 2 mV/div. If necessary, readjust DC BAL R6 (R7). During the adjustment, the trace must be kept in the centre of the screen by means of POSITION potentiometer R11 (R12).
– Check that the position of the trace is the same in positions 2, 5, 10, 50 and 100 mV/cm of AMPL switch SK17 (SK18); the maximum allowable difference 0.2 div.

3.2.4.3. Gate current (R126, R326)

– Depress Y_A (Y_B) switch SK4 (SK5), BEAM SELECTOR switch A SK14 (B SK15) and + switch SK8.
– Set AMPL switch SK17 (SK18) to 2 mV/div.
– Check that the trace does not jump when AC-0-DC switch SK16 (SK19) is switched from 0 to DC; if necessary, readjust potentiometer R126 (R326); Fig. 3.19. tolerance at final check 0.4 div.

3.2.4.4. Pre-amplifier (R64, R99, R264, R299)

– Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
– Set TIME/div switch SK2 to 10 ms and TIME/div potentiometer R2 to CAL.
– Set AC-0-DC switch SK16 (SK19) to DC.
– Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
– Apply a square-wave voltage of 600 $mV_{p\text{-}p}$, 100 Hz, to Y_A (Y_B) input socket BU3 (BU5).
– Check that the pulse top is straight; if necessary, readjust potentiometer R99 (R299), Fig. 3.18.
– Set AMPL switch SK17 (SK18) to 2 mV/div.
– Decrease the input voltage to 12 $mV_{p\text{-}p}$.
– Check that the pulse top is straight; if necessary, readjust potentiometer R64 (R264), Fig. 3.19.
– Check that in the ranges 50, 20, 10 and 5 mV/div of AMPL switch SK17 (SK18) the top is straight; tolerance 1 %.

3.2.4.5. Sensitivity (R111, R311)

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to 2 ms and TIME/div potentiometer R2 to CAL.
- Set AC-0-DC switch SK16 (SK19) to DC.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Apply a voltage of exactly 600 mV_{p-p}, 2 kHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the trace height is exactly 6 div; if necessary, readjust potentiometer R111 (R311), Fig. 3.18.
- Check that the control range of AMPL potentiometer R4 (R5) is 1:2,6 to 1:4.

3.2.4.6. Input attenuator (C28, C29, C33, C34, C52, C228, C229, C233, C234, C235, C252)

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to 50 μs and TIME/div potentiometer R2 to CAL.
- Set AC-0-DC switch SK16 (SK19) to DC.
- Connect a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 200 ns to Y_A (Y_B) input socket BU3 (BU5).
- Check that no overshoot is visible (maximum pulse top errors 2 %) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.19.) mentioned in the following table:

Position AMPL switch SK17 (18)	Signal to Y_A (Y_B) BU3 (5)	Adjust with	Trace height
2 mV/div	12 mV	C52 (C252)	6 div + or −2 %
5 mV/div	30 mV	C52 (C252)	6 div + or −2 %
10 mV/div	60 mV	C52 (C252)	6 div + or −2 %
20 mV/div	120 mV	C52 (C252)	6 div + or −2 %
50 mV/div	300 mV	C52 (C252)	6 div + or −2 %
.1 V/div	600 mV	C52 (C252)	6 div + or −2 %
.2 V/div	1,2 V	C28 (C228)	6 div + or −2 %
.5 V/div	3 V	C28 (C228)	6 div + or −2 %
1 V/div	6 V	C28 (C228)	6 div + or −2 %
2 V/div	12 V	C33 (C233)	6 div + or −2 %
5 V/div	30 V	C33 (C233)	6 div + or −2 %
10 V/div	60 V	C33 (C233)	6 div + or −2 %

- Set AMPL switches SK17 and SK18 to .1 V/div.
- Apply a square-wave voltage of 1,2 V_{p-p} repetition rate 10 kHz, rise time not exceeding 200 ns, to Y_A, input socket BU3 via a 2:1 dummy measuring probe consisting of a 1 MOhm resistor and a 30 pF trimmer in parallel. If higher voltages are available, a 10:1 attenuator probe may be used.
- Adjust the trimmer of the dummy probe for optimum square-wave response.
- Apply the input signal via the dummy probe to Y_B input socket BU5.
- Check that the top of the displayed pulse is straight; if necessary, readjust trimmer C235 (Fig. 3.19.).
- Connect, via the dummy probe, a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of 10 kHz and a rise time not exceeding 200 ns to Y_A (Y_B) input socket BU3 (BU5).
- Check that neither overshoot nor rounding is visible (maximum pulse top errors 3 %) and also check the trace height; if necessary, correct the pulse top errors with the aid of the trimmers (Fig. 3.19.) mentioned in the following table

Position AMPL switch SK17 (18)	Signal to 2:1 dummy	Adjust with	Trace height
.2 V/div	2,4 V	C29 (C229)	6 div + or −2 %
.5 V/div	6 V	C29 (C229)	6 div + or −2 %
1 V/div	12 V	C29 (C229)	6 div + or −2 %
2 V/div	24 V	C34 (C234)	6 div + or −2 %
5 V/div	60 V	C34 (C234)	6 div + or −2 %
10 V/div	60 V	C34 (C234)	3 div + or −3 %

3.2.4.7. Square-wave response (C901, C1001, C902, C1002, C62, C262, R113, R313)

- Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8, AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set TIME/div switch SK2 to .2 μs and TIME/div potentiometer R2 to CAL.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Set AC-0-DC switch SK16 (SK19) to AC.
- Apply a square-wave voltage of 600 mV, repetition rate 1 MHz, rise time 1 ns.
- Check the square-wave response. The pulse top errors must not exceed 3 %, maximum permissible overshoot is 2 %; if necessary, readjust trimmers C901 (C1001), C902 (C1002) and C62 (C262) or select a different value for resistor R113 (R313).
- Set AMPL switch SK17 (SK18) to 0.2 mV/div.
- Decrease the input voltage to 12 mV.
- Check that the pulse top errors do not exceed 3 % and the overshoot more than 2 %.

3.2.4.8. Bandwidth of the vertical amplifiers

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 (R5) to CAL.
- Check the bandwidth at a trace height of 6 div in accordance with the following table

Input sine wave on Y_A (Y_B) socket	*Frequency*	*Required trace height*
600 mV_{p-p}	100 kHz	6 div
600 mV_{p-p}	10 MHz	at least 4,2 div

3.2.4.9. Signal delay equality

Note: This check is only necessary if a new delay line has been fitted.

- Depress Y_A (Y_B) switch SK4 (SK5), + switch SK8 auto switch SK10 and BEAM SELECTOR switch A SK14 (B SK15).
- Set AC-0-DC switch SK16 (SK19) to AC.
- Set AMPL switch SK17 (SK18) to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 μs/div and TIME/div potentiometer R2 to CAL.
- Pull TB-MAGN. switch SK1 to position 5x.
- Apply a square-wave voltage of 600 mV, repetition rate 1 MHz, rise time 1 ns to input sockets Y_A BU3 and Y_B BU5. The connection cables to the input sockets should have the same length and characteristics.
- Make the pictures coincide with the aid of control knobs Y POSITION.
- Check that there is no difference in delay time between the amplifiers of channels Y_A and Y_B (0,1 div is acceptable). If necessary, reduce the length of one of the delay lines.

3.2.4.10. H.F. deflection and cross-talk

- Depress Y_A (Y_B) switch SK4 (SK5), AUTO switch SK10, X MAGN SK1 and BEAM SELECTOR switches SK14 and SK15.
- Set AMPL switch SK17 (SK18) to 50 mV/div and AMPL potentiometer R4 (R5) to CAL.
- Apply a sine-wave voltage of 1,2 V_{p-p}, frequency 3 MHz, to Y_A (Y_B) input socket BU3 (BU5).
- Check that the peaks of the signal can be displayed fairly undistortedly within the graticule, using POSITION potentiometer R11 (R12).
- Set AMPL switches SK17 & SK18 to .1 V/div and AMPL potentiometers R4 & R5 to CAL.
- Apply a sine-wave signal 1,2 V, frequency 3 MHz, to Y_A input socket BU3.
- Set AC-0-DC switch SK19 to 0.
- Check that the height of the Y_B trace does not exceed 0,2 div.
- Set AMPL switches SK17 & SK18 to 50 mV/div and AMPL potentiometers R4 & R5 to CAL.
- Apply the input signal to Y_B input socket BU5.
- Set AC-0-DC switch SK16 to 0.
- Check that the height of the Y_A trace does not exceed 0,2 div.

3.2.5. TRIGGERING

3.2.5.1. Trigger pre-amplifier (R414)

- Depress Y_A switch SK4, + switch SK8, AC switch SK11 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set AC-0-DC switch SK16 to AC.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Apply a sine-wave signal of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Set LEVEL potentiometer R3 to such a position that the trace starts at the zero level of the sine-wave.
- Depress DC switch SK12.
- Check that the trace starts at the same point; if necessary, readjust potentiometer R414 (Fig. 3.14.).
- Decrease the input voltage to 80 mV.
- Adjust LEVEL potentiometer R3 for a triggered display.
- Check that the display is still triggered when AC switch SK11 is depressed.
- Depress BEAM SELECTOR switch B SK15, Y_B switch SK5 and DC switch SK12.
- Apply the 80 mV input signal to Y_B socket BU5.
- Set AMPL switch SK18 to .1 V/div and AMPL potentiometer R5 to CAL.
- Adjust LEVEL potentiometer R3 for a triggered display.
- Depress AC switch SK11; the starting point of the trace must not move more than 1 div.

3.2.5.2. Long-tailed pair circuit (R424)

- Depress Y_A switch SK4, – switch SK9, AUTO switch SK10 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Set AC-0-DC switch SK16 to AC.
- Apply a sine-wave voltage of 80 mV_{p-p}, frequency 2 kHz, to Y_A socket BU3.
- Check that the display remains stationary when LEVEL potentiometer R3 is rotated from fully anti-clockwise to fully clockwise; if necessary, readjust potentiometer R424 (Fig. 3.17.).

3.2.5.3. Trigger slope

- Depress Y_A switch SK4, AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Apply a sine-wave signal of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Adjust LEVEL potentiometer R3 for a stationary display.
- Check that the display starts with the positive slope of the signal.
- Depress – switch SK9.
- Check that the display starts with the negative slope of the signal.

3.2.5.4. Level range with external triggering

- Depress EXT switch SK6, AC switch SK11, + switch SK8 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to 10 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Apply a sine-wave voltage of 20 V_{p-p}, frequency 2 kHz, to both TRIGG input socket BU2 and Y_A input socket BU3.
- Check that the time-base generator cuts out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.
- Depress – switch SK9 and repeat the check.

3.2.5.5. Level and level range

- Depress Y_A switch SK4, AUTO switch SK10, + switch SK8 and BEAM SELECTOR switch A SK14.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set TIME/div switch SK2 to .2 ms and TIME/div potentiometer R2 to CAL.
- Apply a sine-wave voltage of 600 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Check that the starting point of the trace moves upwards when LEVEL potentiometer R3 is turned clockwise.
- Check that the starting point of the trace can be shifted over 5 div by means of LEVEL potentiometer R3.
- Depress AC switch SK11.

– Set AMPL switch SK17 to 50 mV/div.
– Check that the time-base generator cuts out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.
– Check AMPL SK17 switch to 20 mV/div.
– Check that the time-base generator does not cut out when LEVEL potentiometer R3 is turned fully anti-clockwise and fully clockwise.

3.2.5.6. Mains triggering

– Depress EXT switch SK6, + switch SK8, AUTO switch SK10 and BEAM SELECTOR switch A SK14.
– Set TIME/div switch SK2 to 20 ms and TIME/div potentiometer R2 to CAL.
– Apply a voltage with the mains frequency to Y_A input socket BU3; trace height 1 div.
– Check that the oscilloscope displays a moving sine wave.
– Depress MAINS switch SK7.
– Check that the display is stationary.

3.2.5.7. Trigger sensitivity

– Set AC-0-DC switches SK16 and SK19 to DC.
– Set LEVEL potentiometer R3 to obtain a stationary display.
– Set TIME/div switch SK2 so that a reasonable number of cycles is displayed.
– Check the trigger sensitivity in accordance with the following table.

Input signal to	*Frequency (sine wave)*	*Depress source switch*	*Depress mode switch*	*Depress BEAM SELECTOR*	*Triggering at*
Y_A BU3	20 Hz	Y_A SK4	AUTO SK10	A SK14	0,8 div
	10 MHz				0,8 div
	20 Hz		AC SK11		0,8 div
	10 Hz				0,8 div
	5 Hz		DC SK12		0,8 div
	10 MHz				0,8 div
Y_B BU5	20 Hz	Y_B SK5	AUTO SK10	B SK15	0,8 div
	10 MHz				0,8 div
TRIGG BU2 & Y_B BU5	20 Hz	EXT SK6		B SK15	0,8 V
	10 MHz				0,8 V

3.2.5.8. Single-sweep operation

– Turn PERSISTENCE potentiometer R10 entirely anti-clockwise.
– Depress WRITE switch SK25.
– Depress BEAM SELECTOR switch SK14, BEAM SELECTOR switch SK15 in released position.
– Set AMPL switch SK17 to 50 mV/div.
– Set TIME/div switch SK2 to 50 ms/div.
– Apply a sine-wave of 600 mV, frequency 1 kHz to Y_A input socket BU3.
– Depress AUTO switch SK10 and Y_A switch SK4.
– Set AC-0-DC switch SK16 to AC.
– Set LEVEL potentiometer R3 to its mid-position.
– Depress SINGLE switch SK13 (RESET lamp LA4 is out).
– Push RESET button SK26 (RESET lamp LA4 is out).
The sweep runs only once, and displays a trace. If necessary, readjust the stability, for this see point 3.2.3.1.
– Depress AC switch SK11.
– Set AC-0-DC switch SK16 to 0.
– Push RESET button SK26, and ascertain that its associated lamp (LA4) lights.
– Set AC-0-DC switch SK16 to AC.
The sweep runs only once, after the sweep is completed the RESET lamp (LA4) goes out.

3.2.6. TIME-BASE GENERATOR AND HORIZONTAL AMPLIFIER

Note: For adjustment of the stability (R553) see point 3.2.3.1.

3.2.6.1. Time coefficients (R534, R539, R618)

- Depress Y_A switch SK4, + switch SK8, AUTO switch SK10, X MAGN switch SK1 and BEAM SELECTOR switch A SK14.
- Set TIME/div potentiometer R4 to CAL.
- Set LEVEL potentiometer R3 to its mid-position.
- Set TIME/div switch SK2 to .5 ms.
- Check that the length of the time-base is 10 to 10,5 div, if necessary, readjust potentiometer R618 (Fig. 3.17.).
- Set TIME/div switch SK2 to 20 μs.
- Apply a time marker voltage with a repetition time of 20 μs to Y_A input socket BU3.
- Check that the 8 centre periods have a total width of 8 div; if necessary, readjust potentiometer R534 (Fig. 3.17.).
- Set TIME/div switch SK2 to 20 ms.
- Change the repetition time of the input signal to 20 ms.
- Check that the 8 centre periods have a total width of 8 div; if necessary, readjust potentiometer R539 (Fig. 3.17.).
- Check that in the other positions of TIME/div switch SK2 the 8 centre periods have a total width of 8 div + or −4 % (the repetition time of the input signal must always correspond to the setting of TIME/div switch SK2).
- Check that the length of the time-base line is 10 to 12 div in all positions of TIME/div switch SK2.
- Check that the control range of TIME/div potentiometer R2 is 1:2,6 to 1:5.

3.2.6.2. Magnification and shift (R617)

- Depress Y_A switch SK4, + switch SK8, AUTO switch SK10 and BEAM SELECTOR A SK14.
- Set TIME/div switch SK2 to 20 μs and TIME/div potentiometer R2 to CAL.
- Apply a time marker voltage with a repetition time of 20 μs to Y_A input socket BU3.
- Pull X MAGN switch SK1 to x5.
- Shift every cycle on to the screen by means of X POSITION potentiometer R1 and check that each cycle has a width of 5 div + or −2 %; if necessary, readjust potentiometer R617 (Fig. 3.17.).
- Check that with X POSITION potentiometer R1 the beginning and the end of the time-base line can be displayed within the graticule.
- Set TIME/div switch SK2 to .2 μs.
- Change the repetition time of the input signal to .2 μs.
- Check that the widths of all periods are equal within + or −2 %.

3.2.7. MAINS VOLTAGE FLUCTUATIONS

- Vary the mains voltage + and −10 % with respect to the nominal mains voltage as indicated by the voltage adapter.
- Check that the vertical and horizontal deflection are not affected and that the brightness does not change.

3.2.8. BEAM SELECTION

- Depress X MAGN switch SK1 to x1.
- Depress AUTO switch SK10.
- Set TIME/div switch SK2 to 1 ms.
- Set AMPL switches SK17 and SK18 to .1 V/div.
- Depress BEAM SELECTOR switch A SK14.
- Check that only the channel Y_A time-base line is visible.
- Release BEAM SELECTOR switch A SK14 and depress B SK15.
- Check that only the channel Y_B time-base line is visible.

3.2.9. X-Y OPERATION (R601)

- Depress AUTO switch SK10, X MAGN SK1 and BEAM SELECTOR SWITCHES A SK14 and B SK15.
- Set TIME/div switch SK2 to 5 ms.
- Set AMPL switch SK17 to .1 V/div and AMPL potentiometer R4 to CAL.
- Set POSITION potentiometer R11 to its mid-position.
- Set AC-0-DC switch SK16 to AC.
- Set X POSITION potentiometer R1 to such a position that the time-base lines start at the beginning of the measuring graticule.
- Centre the Y_B time-base line by means of POSITION potentiometer R12.
- Set TIME/div switch SK2 to position X via Y_A.
- Check that the spot is displayed in the centre of the screen; tolerance + or −5 div.
- Check that no Y_A trace is visible, also when POSITION potentiometer R11 is rotated.
- Apply a sine-wave voltage of 800 mV_{p-p}, frequency 2 kHz, to Y_A input socket BU3.
- Centre the trace by means of X POSITION potentiometer R1.
- Check that the trace width is 8 div + or −0,4 div; if necessary, readjust potentiometer R601 (Fig. 3.17.).
- Increase the frequency of the input voltage to 1 MHz.
- Check that the trace width is at least 6 div.

3.2.10. OUTPUT SOCKETS

3.2.10.1. Calibration voltage on CAL socket BU1 (R761)

- Check, with the aid of an accurate peak-peak voltmeter, that the voltage on CAL socket BU1 has a value of 600 mV_{p-p} + or −0,5 %; if necessary, readjust potentiometer R761 (Fig. 3.17.).
- Check that the pulse does not show overshoot and that the repetition frequency is 2 kHz + or −20 %.

3.2.10.2. Time-base voltage on TB OUT socket BU6

- Depress AUTO switch SK10.
- Set TIME/div switch SK2 to 2 ms.
- Check that the amplitude of the sawtooth voltage on TB OUT socket BU6 is 6 V + or −20 %, if terminated with a resistor of 1 MΩ.

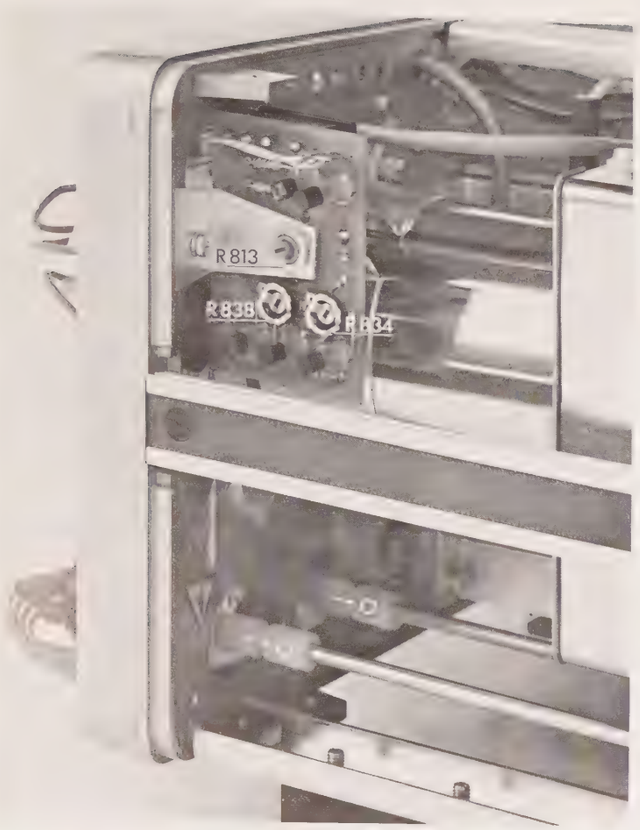


Fig. 3.18. Adjusting and dismantling

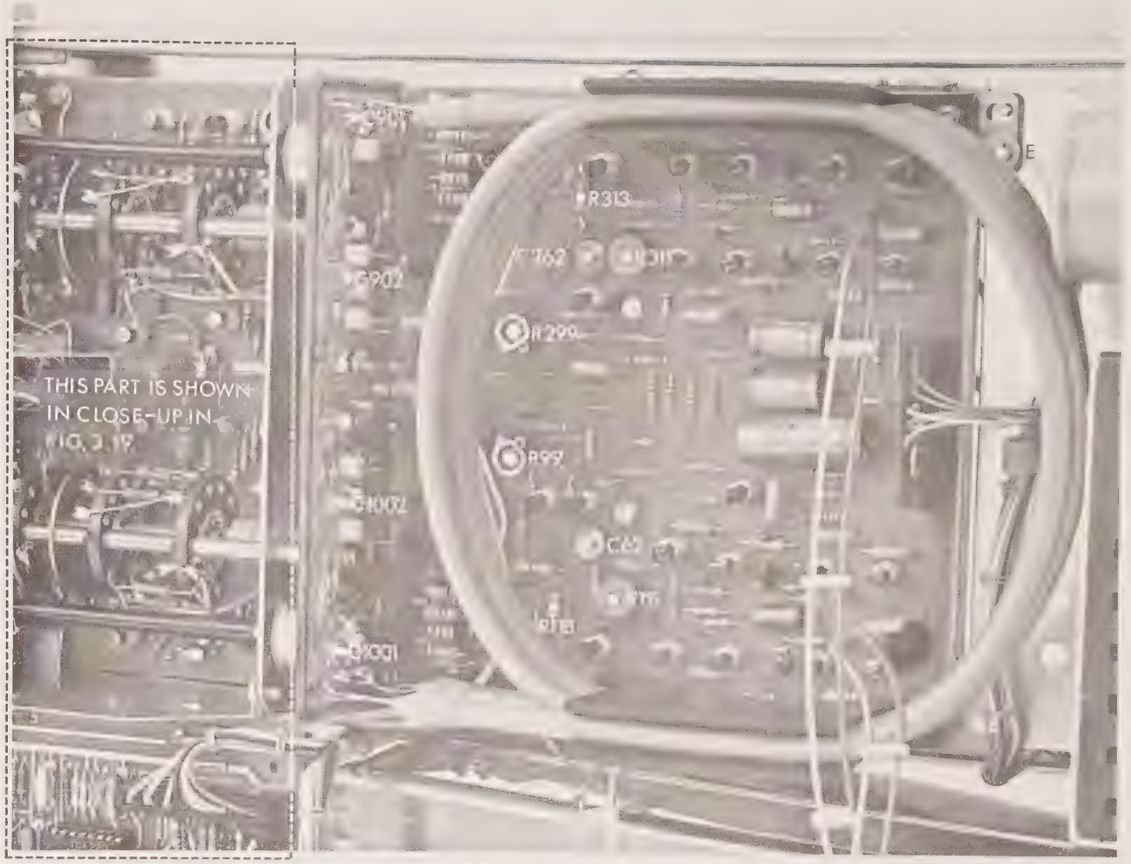


Fig. 3.18. Adjusting and dismantling

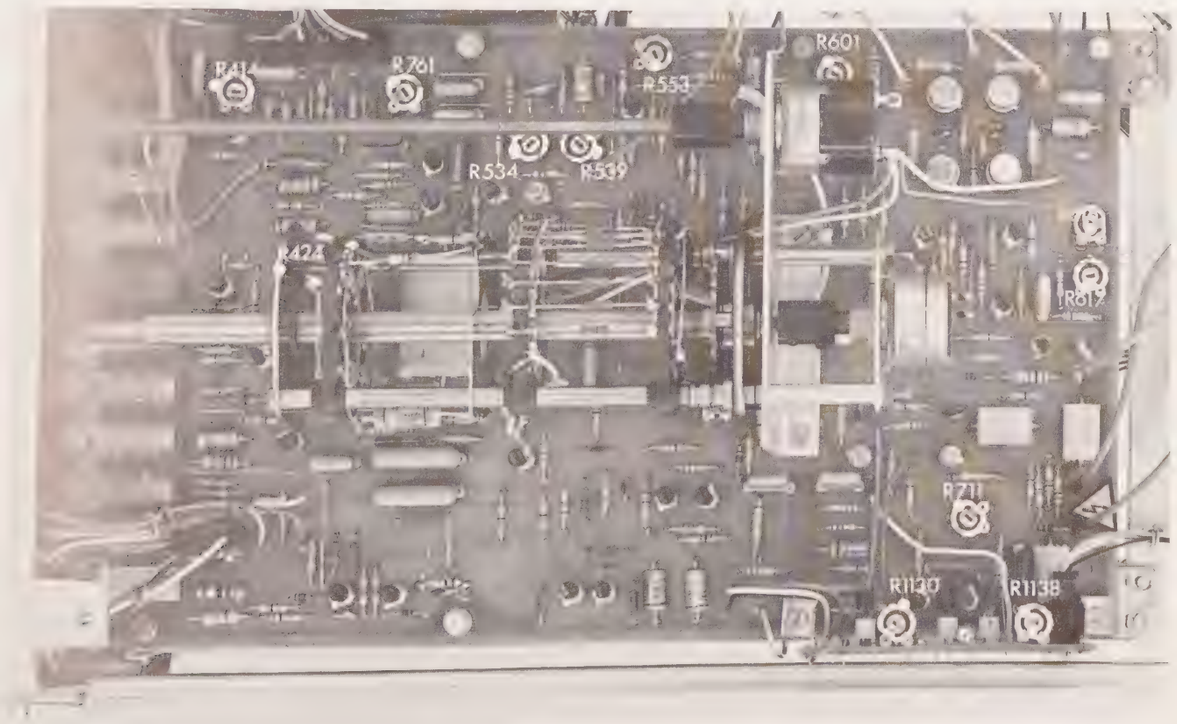


Fig. 3.17. Adjusting

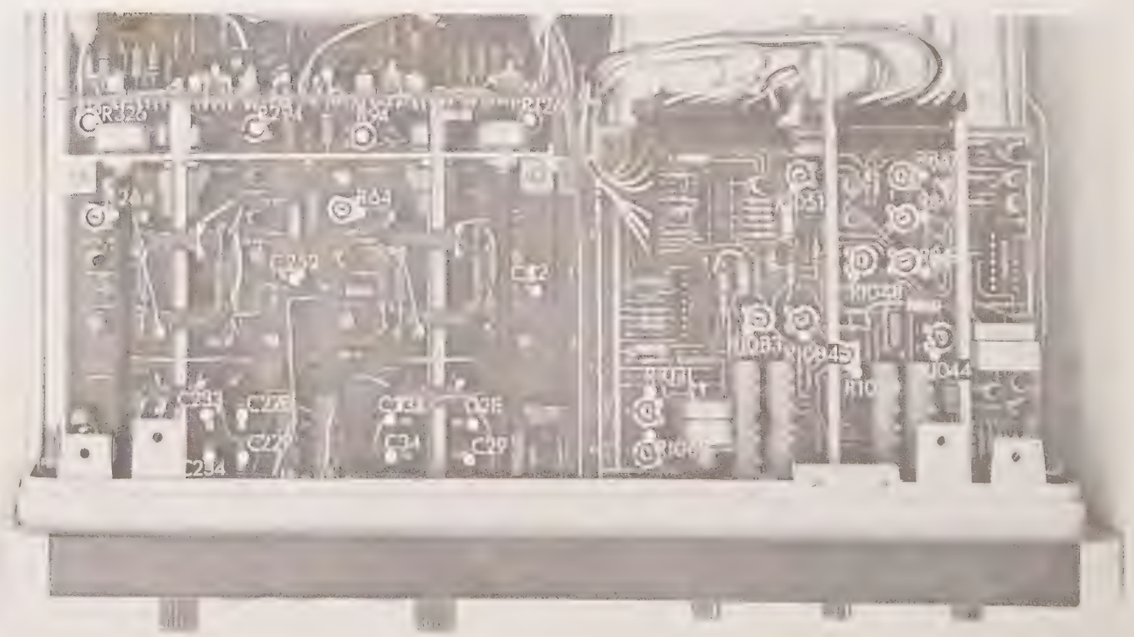


Fig. 3.19. Adjusting

3.3. Dismantling the instrument

3.3.1. WARNING

The opening of parts of the instrument or the removal of covers is likely to expose live conductors.
The instrument must, therefore, be disconnected from all voltage sources before any opening of parts or removal of covers is started.
If the E.H.T. connector of the c.r.t. is disconnected, both connector and c.r.t. must be discharged immediately by shortening them to earth.

3.3.2. KNOBS

3.3.2.1. Knobs of Y POSITION potentiometers R11 & R12 and AC-0-DC switches SK16 & SK19

These knobs can be pulled off the shaft.

3.3.2.2. Single knobs (Fig. 3.20.)

- Remove cap A.
- Slacken screw B.
- Pull the knob off the shaft.

3.3.2.3. Double knobs (Fig. 3.20.)

- Remove cap A.
- Slacken screw B.
- Pull the inner knob off the shaft.
- Slacken nut C.
- Pull the outer knob off the shaft.

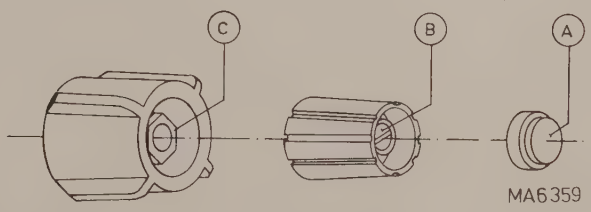


Fig. 3.20. Knobs

3.3.3. BEZEL

- Slightly lift the lower part of the bezel and swivel it upwards.
- Subsequently mask, contrast filter and measuring graticule can be removed.

3.3.4. CABINET PLATES

Top and bottom cabinet plates can be taken off after removing four screws for each plate.

3.3.5. PILOT LAMP

– Remove the bezel with graticule, filter and mask.
– Squeeze lamp holder flanges slightly inwards and push the lamp holder out of the frame. Be careful not to mechanically load the soldering tags of the lamp holder, as they break easily.
The bulb is then accessible:

To refit:
– Push the lamp holder back in its opening until the hooks on the flanges snap over the frame.

3.3.6. TEXT PLATE OF C.R.T. CONTROLS

– Remove the bezel with graticule filter and mask.
– Remove the knobs of the PERSISTENCE, FOCUS and INTENS potentiometers.
– Remove the fixing nut around the shaft of the INTENS potentiometer.

3.3.7. STORAGE UNIT

– Unplug all connectors on the storage board.
– Remove the bezel with graticule, filter and mask.
– Remove one screw J (Fig. 3.22.).
– Remove the two recessed-head screws G (Fig. 3.22.) and belonging clamping devices with which the storage board is fitted to the front panel.
– Slide the board out of the instrument.

3.3.8. TIME-BASE UNIT

– Remove the X POSITION, TIME/div and LEVEL knobs.
– Unplug all connectors on the time-base board (a few connectors can be unplugged at the vertical amplifier board).
– Remove two screws A (Fig. 3.21.).
– Remove two screws B (Fig. 3.21.).
– Remove two screws and nuts C (Fig. 3.21.).
– Lift the unit out of the instrument.
– When refitting the unit, make sure that the screening plate between time-base and vertical amplifier unit clicks into place over the cross bars of the frame.

Note:

In order to maintain the mechanical strength of the oscilloscope, the time-base unit and the vertical amplifier unit must not be removed at the same time.

3.3.9. VERTICAL AMPLIFIER UNIT

– Remove the AC-0-DC, AMPL and POSITION knobs.
– Set the AC-0-DC switches SK16 & 19 to 0.
– Remove all connectors on the amplifier board.
– Remove two screws D (Fig. 3.22.).
– Remove two screws E (Fig. 3.18.).
– Remove two screws C (Fig. 3.21.).
– Lift the unit out of the instrument.
– When refitting the unit, make sure that the AC-0-DC switches are in 0 position and that the screening plate between time-base and amplifier unit clicks into place over the cross bars of the frame.

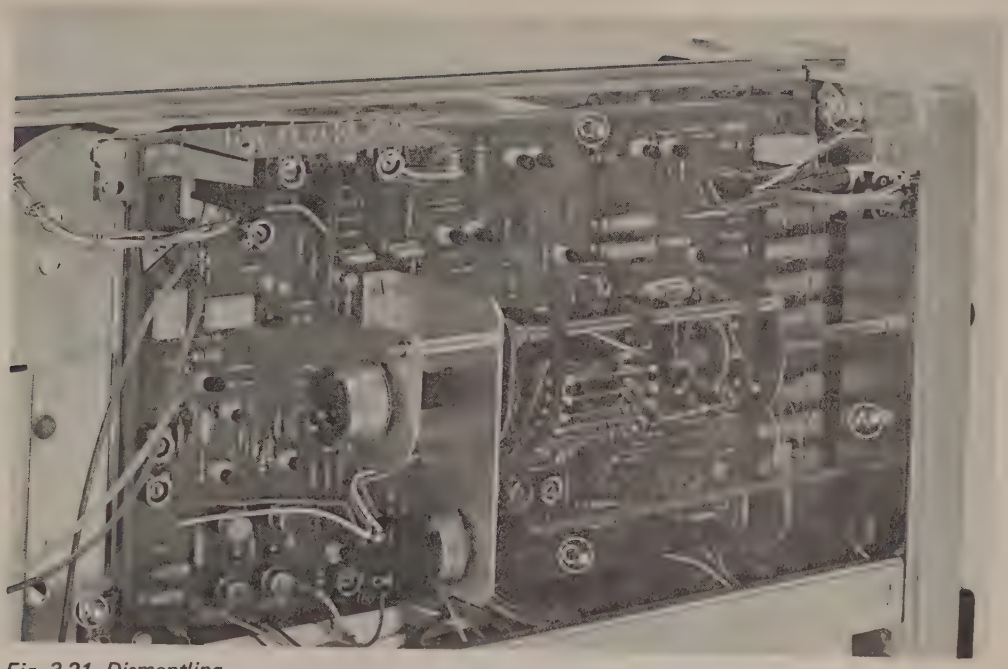


Fig. 3.21. Dismantling

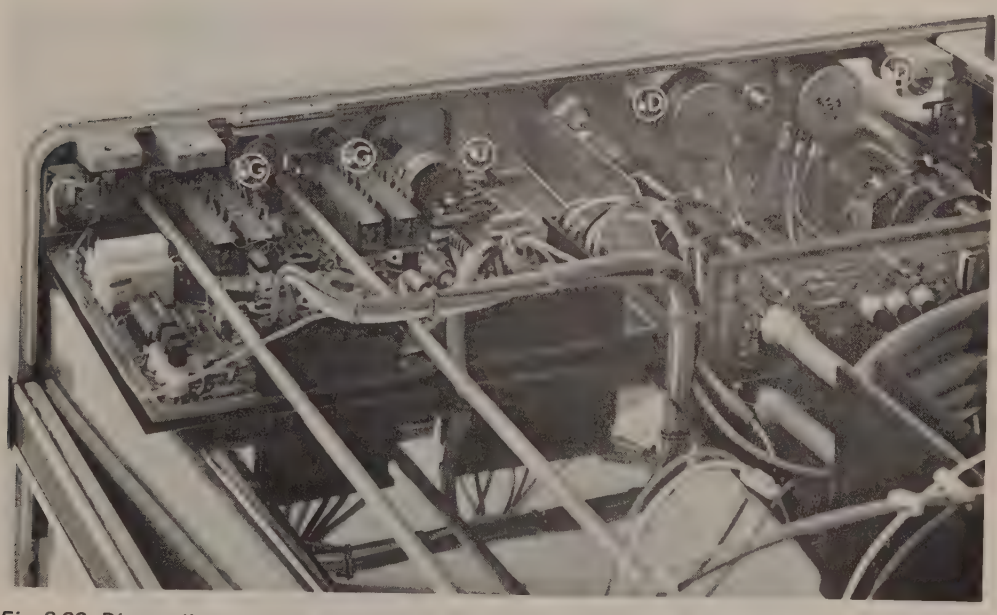


Fig. 3.22. Dismantling

3.3.10. MAIN TEXT PLATE

- Remove all knobs except those of the c.r.t. controls.
- Set the AC-0-DC switches SK16 & 19 to 0.
- Remove the time-base unit.
- Remove the earth connector BU4.
- Remove the retaining clips of the bearings for the X POSITION and the LEVEL potentiometer, and the bearings themselves.
- Unplug the connector of the CAL socket.
- Remove the retaining clip of the CAL socket, and the CAL socket itself.
- Take the text plate out of the front panel.

3.3.11. CATHODE-RAY TUBE

Attention: Be very careful with the side connections of the c.r.t. If these pins are bent, the c.r.t. is likely to develop a gas leak.

- Slacken the brace around the c.r.t. neck by means of screw F.
- Slacken screws K.
- Remove the tube base.
- Remove magnets T and pull the yoke (Y) from the c.r.t. neck.
- Slacken the four screws H and remove the plates.
- Remove the mu-metal screening tube S.
- Remove the bezel with graticule, filter and mask.
- Remove the rubber collar around the front side of the c.r.t.
- Push the c.r.t. to the rear side of the oscilloscope and remove the connections around the c.r.t. neck.
- Push the c.r.t. to the front side of the oscilloscope and remove the connections (discharge connectors and c.r.t. immediately by shortening them to earth).
- Carefully withdraw the c.r.t. through the front panel of the instrument.
- Refitting of the c.r.t. is done in the reverse order.
- Move the c.r.t. in such a way that the tube face is flush with the front of the oscilloscope.
- If the yoke and the rubber sleeve around the neck of the c.r.t. must be slid over the neck of a remplacement tube, the use of industrial talcum powder is strongly recommended.

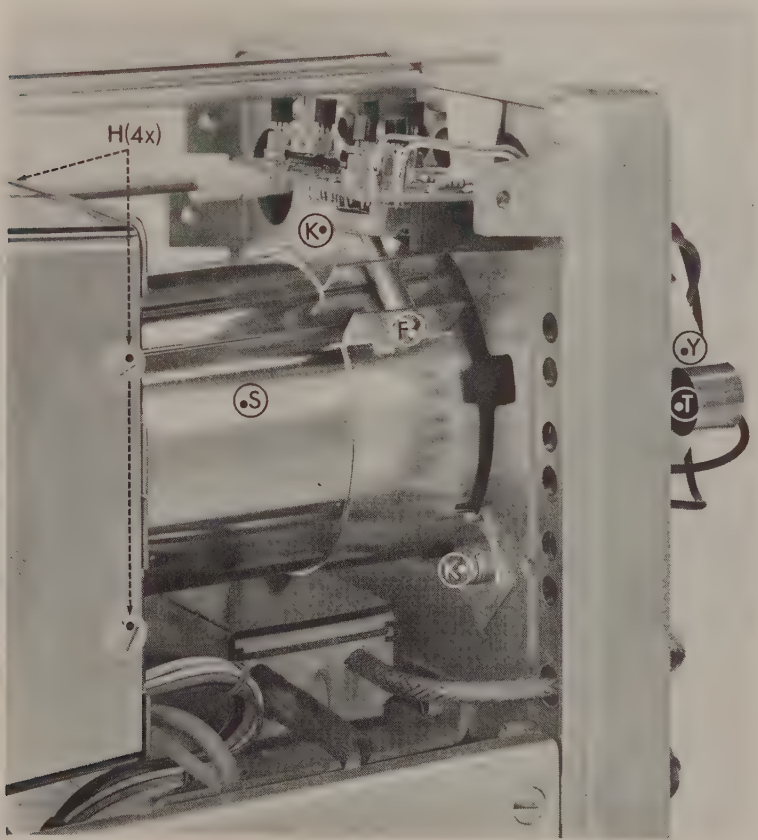


Fig. 3.23. Dismantling

3.3.12. MAINS TRANSFORMER

— Remove the rear cover (three screws X, Fig. 2.1.).
— Unsolder and unplug the relevant connections.
— Remove the three screws L (Fig. 3.24.).
— Take the transformer with voltage adapter and capacitor out of the instrument.

3.3.13. POWER SUPPLY BOARD

If only the components on the board must be made accessible, proceed as follows:
— Remove the rear cover (three screws X, Fig. 2.1.).
— Remove the rear panel with the sockets, by removing the three screws and spacers M (Fig. 3.15.).
— Unplug all connectors on the power supply board.
— If necessary, remove valve holder, magnets and the yoke of the c.r.t. (Fig. 3.23. & 3.25.).
— Remove the five screws N (Fig. 3.15.).
— Swivel the board out of the instrument (Fig. 3.25.).

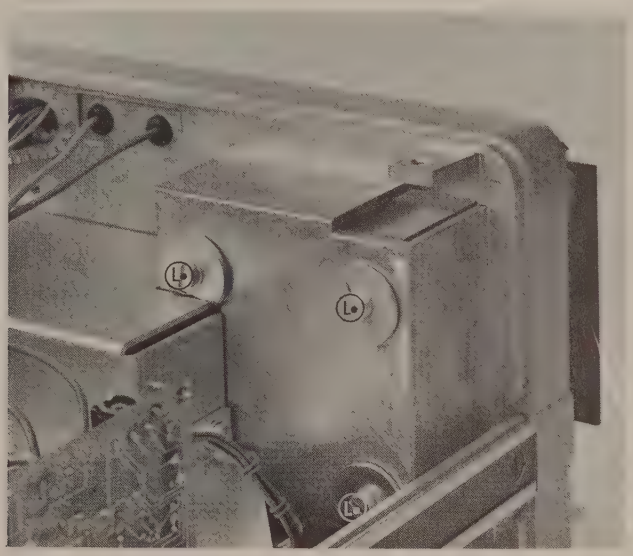


Fig. 3.24. Dismantling

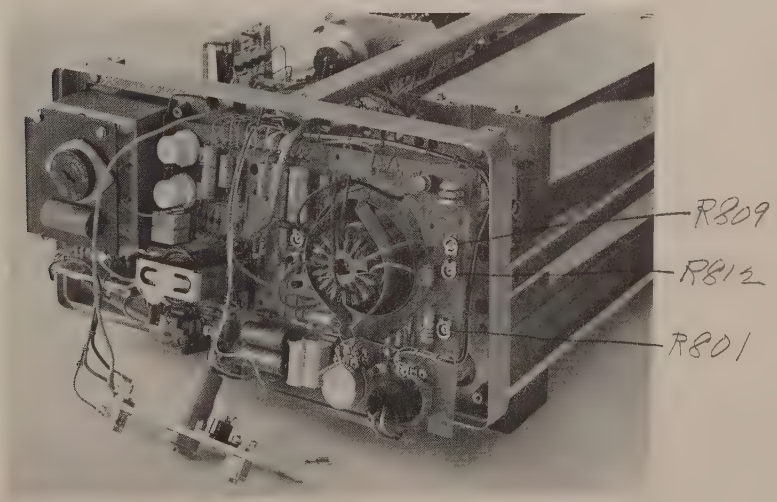


Fig. 3.25. Supply unit swiveled out

If the wiring board must be replaced, also unsolder the remaining connection wires along the sides of the board, including the connection of the mains cable to the POWER ON switch and the connections to the valve holder of the c.r.t.

Note: When replacing the board, make sure that the shafts of the FOCUS and INTENS potentiometers fit properly in the coupling bushes 0 (Fig. 3.16.).

3.3.14. VOLTAGE QUADRUPLER

- Remove the rear cover (three screws X, Fig. 2.1.).
- Remove the E.H.T. connector and discharge the E.H.T. and c.r.t. immediately by shortening them to earth.
- Unsolder the E.H.T. lead at point P on the supply unit (Fig. 3.15.).
- Unsolder the earth wire of the quadrupler.
- Slightly squeeze the quadrupler flanges inside the cable compartment together and pull the quadrupler out.

3.3.15. REPLACING A PUSH-BUTTON SWITCH

- Remove the storage unit in accordance with section 3.3.7. for replacing a switch in this unit.
- Remove the time-base unit in accordance with section 3.3.8., for replacing a switch in this unit.
- Remove the vertical amplifier unit in accordance with section 3.3.9., for replacing a switch in this unit.
- Straighten the 4 retaining plugs of the relevant switches as shown in Fig. 3.26.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron).
- Solder the new switch onto the printed-wiring board.
- Bend the 4 retaining lugs back to their original positions.

N.B.: The YA and + switch are not soldered, so it is sufficient to just straighten the 4 retaining lugs to remove them.

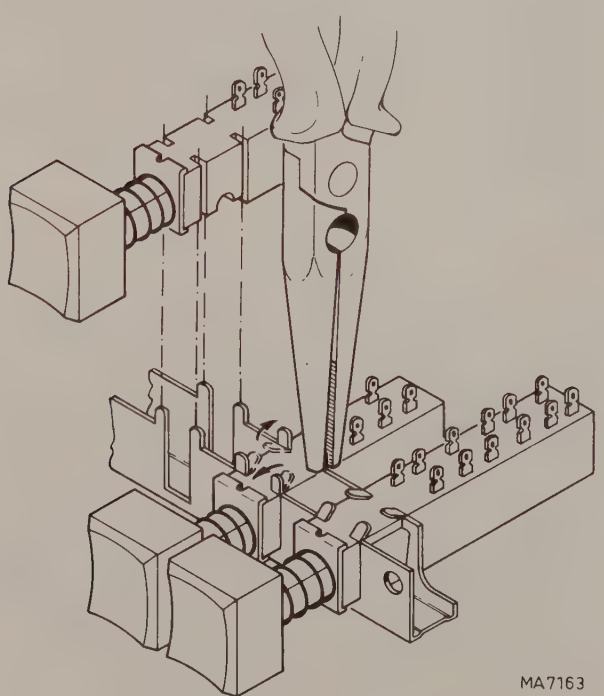


Fig. 3.26. Replacing a push-button switch

3.4. Information for assistance in fault-finding

3.4.1. MAINS TRANSFORMER DATA

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram in the form of a table.

3.4.2. VOLTAGES AND WAVEFORMS IN THE INSTRUMENT

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generator and storage unit are shown at the relevant points on the circuit diagram.

The waveforms have been measured under the following conditions:
– Input signal on Y_A socket BU3: 2 kHz sine-wave voltage for 6 cm deflection.
– LEVEL potentiometer R3 in mid-position.
– TIME/div switch SK2 to .2 ms and X MAGN switch SK1 to x1.
– Y_A, + and AUTO push-buttons SK4, SK8 and SK10 depressed.
– AMPL switch SK17 to 1 V/div.

The voltage values are typical and may slightly differ per instrument.

3.4.3. REMARK

In case of a defect is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:
– Attach a label with your name and address to the instrument.
– Give a complete description of the faults found.
– Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
– Send the instrument to the address obtained after consultation with the local PHILIPS Organization.

3.5. Information concerning accessories

3.5.1. FRONT COVER

This is a plastic cover to protect the oscilloscope front during transport. The cover contains storage space for two passive probes and two BNC to 4 mm adapters. This storage space is accessible after the cover plate has been removed. To this end, bend the lugs A (Fig. 3.27.) slightly inwards and lift off the cover plate.

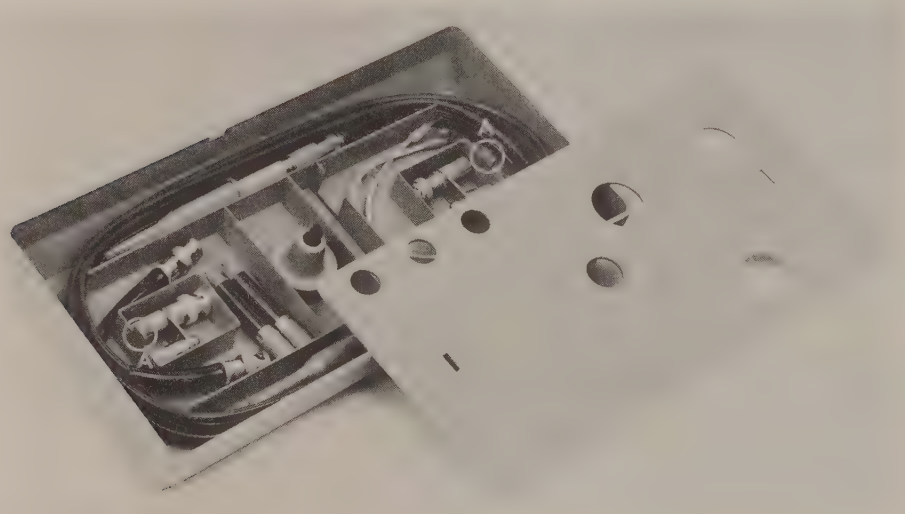


Fig. 3.27. Front cover

3.5.2. ADAPTER PM 9051

This is an adapter to make a BNC socket suitable for the connection of two 4 mm banana plugs.

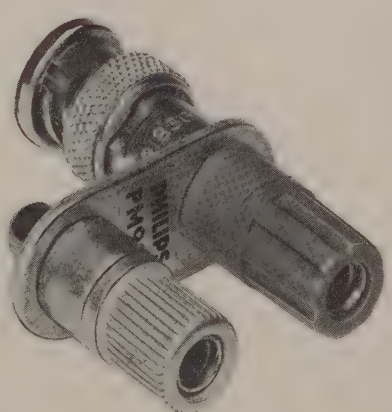


Fig. 3.28. Adapter PM 9051

3.5.3. ATTENUATOR PROBE SETS PM 9326 and PM 9327 (Fig. 3.29.)

These passive probe sets are equal but for the length of the probe cable, which is 1,15 m for the PM 9326 and 2 m for the PM 9327.

The sets consist of:

1 probe cable	Fig. 3.29. item 1
1 earth lead 15 cm	Fig. 3.29. item 2
1 earth lead 30 cm	Fig. 3.29. item 3
1 measuring probe 1:1 (black)	Fig. 3.29. item 4
1 test pin	Fig. 3.29. item 5
1 test hook	Fig. 3.29. item 6
1 attenuator probe 1:10 (grey)	Fig. 3.29. item 7
1 test clip	Fig. 3.29. item 8
1 box	Fig. 3.29. item 9

The measuring probe and the earth lead can be simply pulled from the cable. The test clip, test pin and test hook are screwed on to the measuring probe.

For ordering numbers of these parts, see list 3.6.3.1.

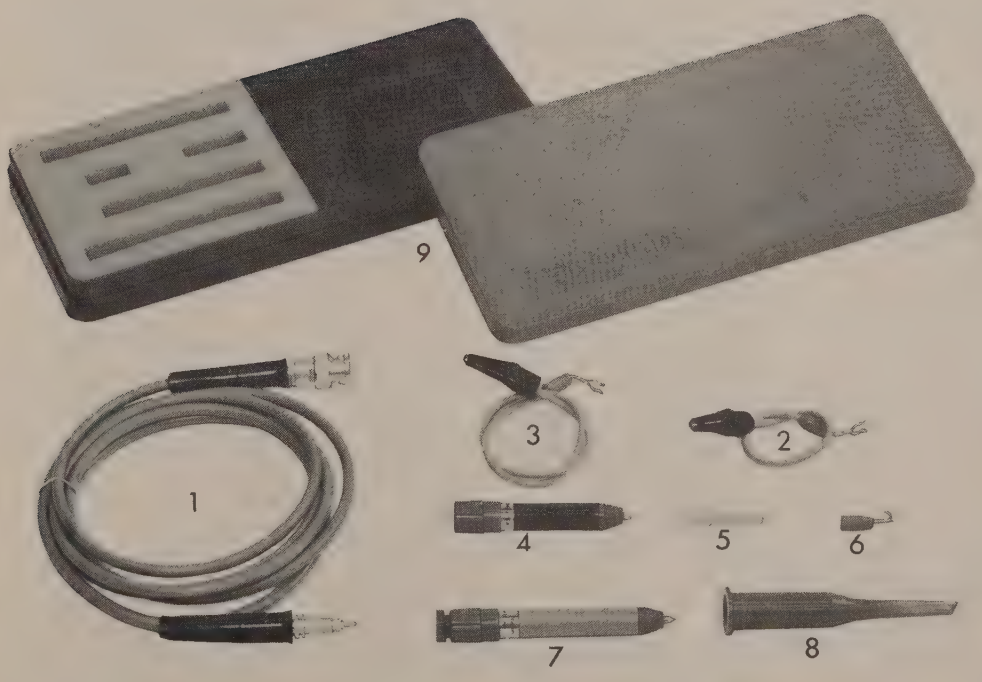


Fig. 3.29. Attenuator probe set PM 9326 (PM 9327)

3.5.3.1. Technical data

Attenuation	1:10 ±3 %
Input impedance	10 MOhm//10 pF
Max. permissible input voltage	1000 V_{p-p}

Maximum d.c. component 500 V with the blocking capacitor included into the circuit.

3.5.3.2. Adjustment (Fig. 3.30.)

- Unscrew the probe locking nut by turning it anti-clockwise.
- Rotate the probe body to change the capacitance while watching the display for the desired waveform.
- When compensation is completed, carefully turn the locking nut clockwise, to lock it without disturbing the adjustment.

The attenuator probe causes distortion if it has not been properly adjusted.

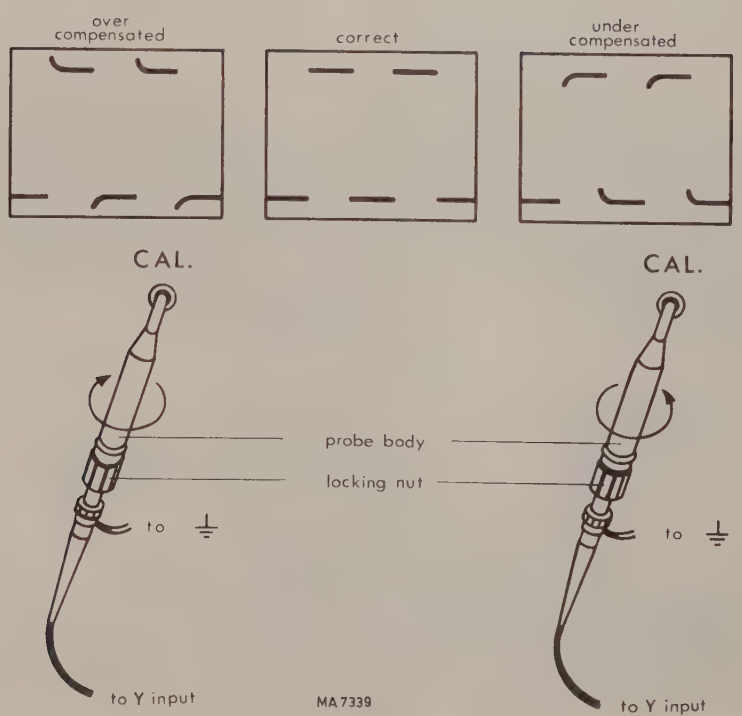


Fig. 3.30. Adjusting an attenuator probe

3.5.4. ATTENUATOR PROBE SETS PM 9336 and PM 9336L

The PM 9336 is a 10x attenuator probe, designed for oscilloscopes up to 25 MHz, having a BNC input jack and 10 to 35 pF input capacitance, paralleled by 1 MΩ. The PM 9336L is a similar probe with a cable length of 2.5 m.

The set consists of:

1 probe assembly	Fig. 3.31. item 1
5 soldering terminals	Fig. 3.31. item 2
1 test hook	Fig. 3.31. item 3
2 spare test hook sleeves	Fig. 3.31. item 4
1 protective cap	Fig. 3.31. item 5
1 probe holder	Fig. 3.31. item 6
2 probe tips	Fig. 3.31. item 7
1 earthing cord	Fig. 3.31. item 8
1 box	item 9

For ordering numbers of these parts, see list 3.6.3.2.

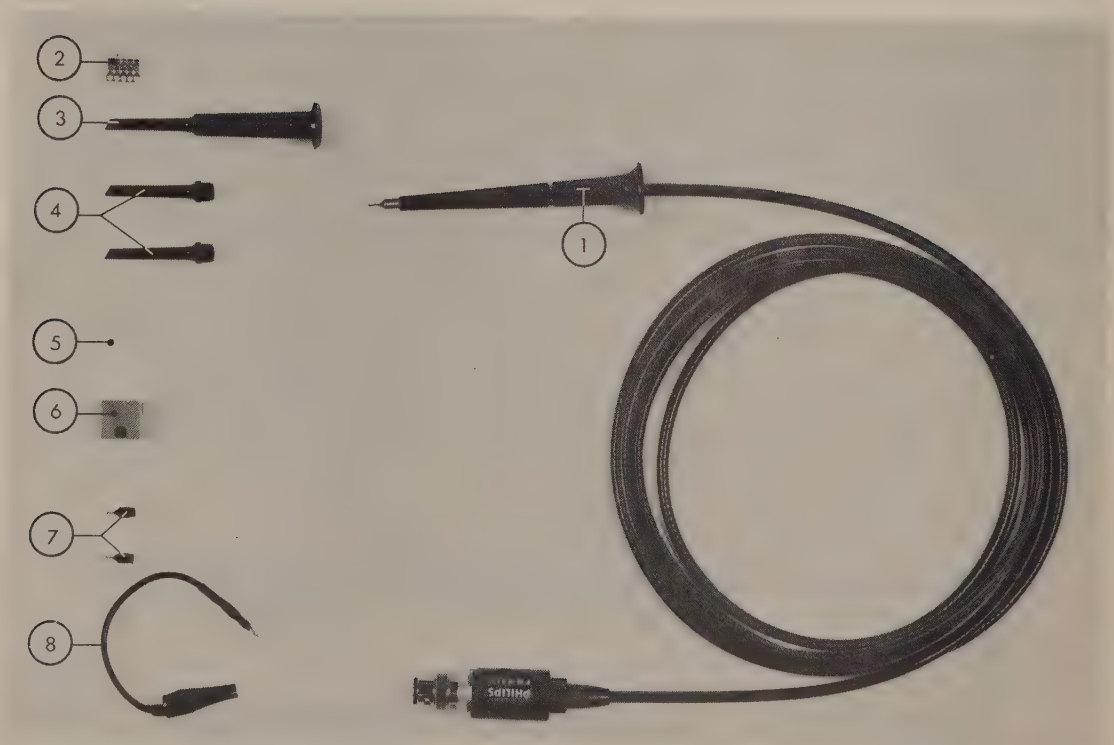


Fig. 3.31. Attenuator probe set PM 9336 (PM 9336L)

3.5.4.1. Technical data

Attenuation	1:10 ±3 %		
Input resistance	PM 9336	10 MOhm	±2 %
	PM 9336L	10 MOhm	±2 %
Input capacitance	PM 9336	11 pF	±1 pF
	PM 9336L	14 pF	±1 pF
Maximum allowable input voltage	500 V (D.C. + A.C. peak)		

3.5.4.2. Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to socket CAL of the oscilloscope.
A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples

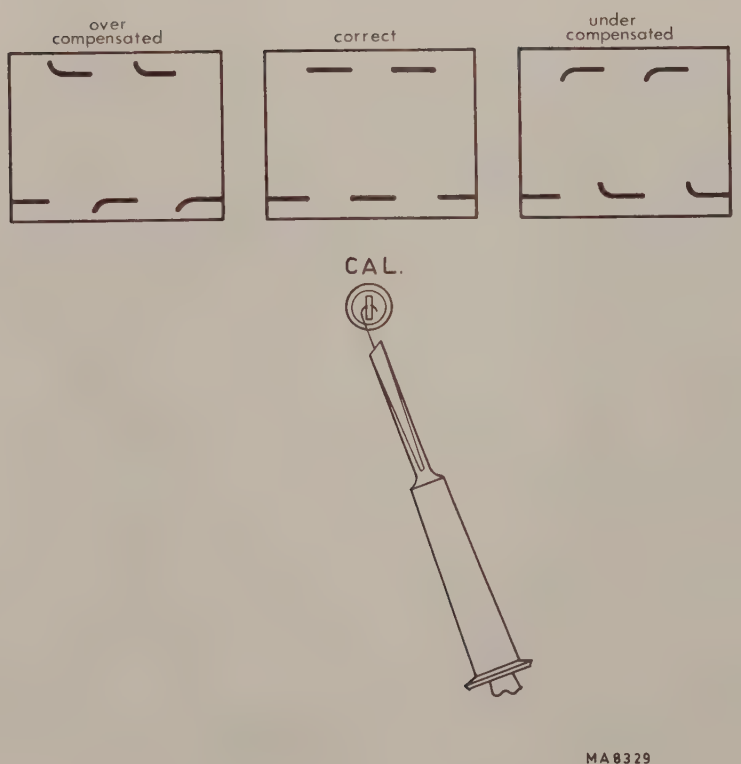


Fig. 3.32. Probe compensation

3.5.5. 1:1 PROBE SETS PM 9335 and PM 9335L

The PM 9335 is a passive probe without signal attenuation for use with oscilloscope, counters and voltmeters having a high input impedance and a BNC input socket.
The cable design is such that the reflections due to the instrument's capacitive load are absorbed.
The useful range of this probe is restricted to d.c. and l.f. applications (up to 10 MHz).
The PM 9335L is a similar probe with a cable length of 2,5 m.

The set consists of:

1 test hook	Fig. 3.33. item 1
2 spare test hook sleeves	Fig. 3.33. item 2
2 spare probe tips	Fig. 3.33. item 3
1 protective cap	Fig. 3.33. item 4
1 earthing lead	Fig. 3.33. item 5
1 probe holder	Fig. 3.33. item 6
1 probe assembly	Fig. 3.33. item 7
1 box	item 8

For ordering numbers of these parts, see list 3.6.3.3.

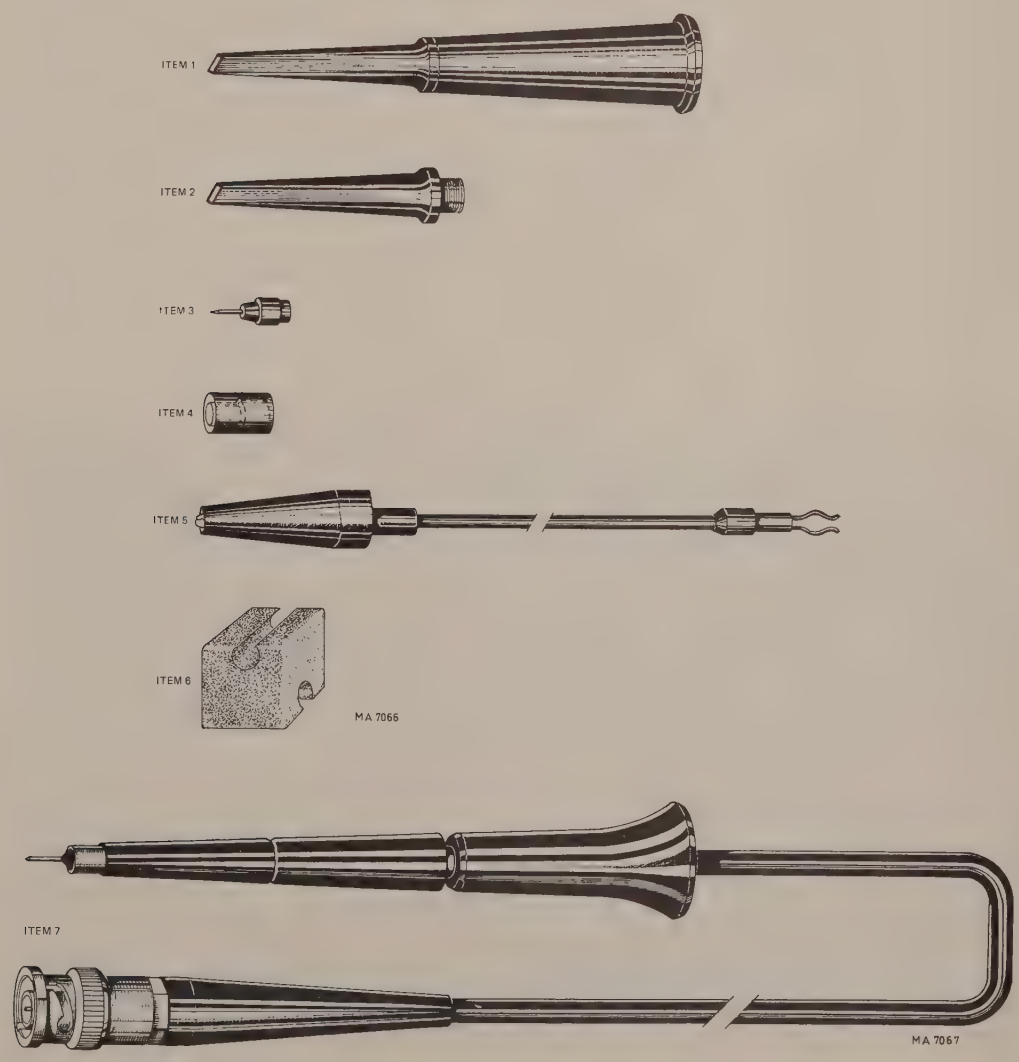


Fig. 3.33. Probe set PM 9335

3.5.5.1. Technical data

Attenuation	1:1
Input resistance	1 MOhm
Input capacitance	45 ±5 pF + input cap. of measuring instrument

Max. allowable input voltage

D.C.	500 V
A.C. peak-to-peak	500 V derating at higher frequencies with $\frac{500\ V}{MHz}$
A.C. peak + D.C.	500 V

Dimensions	**L**	**W**	**H**
Probe body	105		mm
Cable	1.5		m
Box	230	104	24 mm

3.5.6. 2 kV ATTENUATOR SET PM 9358

The PM 9358 is a 100x attenuator probe which can handle signals up to 2 kV_{rms}. The probe has been designed for use with oscilloscopes having a bandwidth up to 150 MHz, a BNC input jack and an input impedance of 1 MΩ paralleled by 14 to 21 pF.

The set consists of:

1 probe assembly	Fig. 3.34. item 1
5 soldering terminals	Fig. 3.34. item 2
1 test hook	Fig. 3.34. item 3
1 spare test hook sleeve	Fig. 3.34. item 4
1 protective cap	Fig. 3.34. item 5
1 insulating cap	Fig. 3.34. item 6
1 probe holder	Fig. 3.34. item 7
2 spare test pins	Fig. 3.34. item 8
1 earthing cord	Fig. 3.34. item 9
1 box	item 10

For ordering numbers of these parts, see list 3.6.3.4.

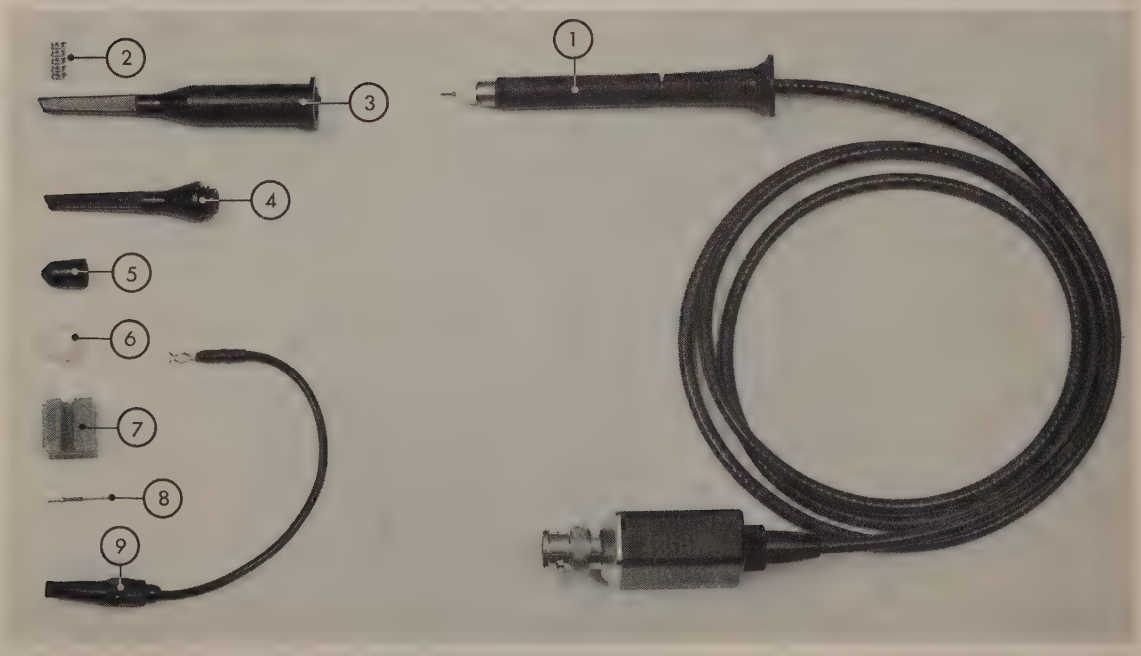


Fig. 3.34. Attenuator probe set PM 9358

3.5.6.1. Technical data

Attenuation		1:100 ±2 %
Input resistance		20 MOhm ±3 %
Input capacitance		2 pF ±0.3 pF
Max. allowable voltage DC or AC_{rms}		
Continuous	2 kV	
Under pulsed conditions	2 kV	Duty cycle 50 - 100 % dv/dt ⩽ 1000 V/ns Pulse rep. frequency ⩽ 1 MHz
	3 kV	Duty cycle 25 - 50 % dv/dt ⩽ 500 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 100 ms
	4 kV	Duty cycle 0 - 25 % dv/dt ⩽ 200 V/ns Pulse rep. frequency ⩽ 1 MHz Max. pulse duration 20 ms
Sine waves continuous	5,6 kV_{p-p}	For frequencies up to 1 MHz

3.5.6.2. Adjustment

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary. Connect the measuring pin to socket CAL of the oscilloscope. A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.

See the following examples:

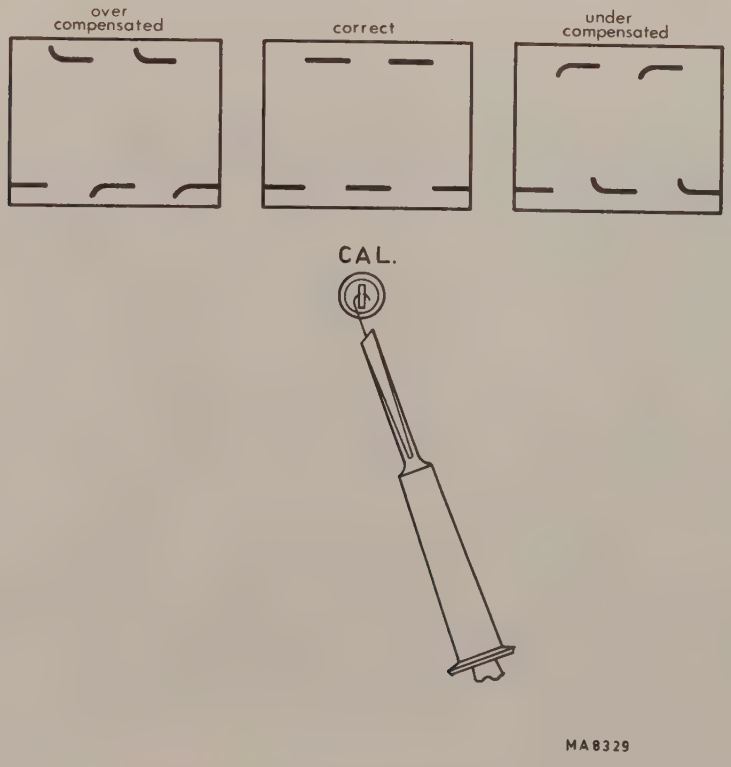


Fig. 3.35. Probe compensation

3.5.7. SET OF EAGLE CLIPS PM 9333

PM 9333 Set of eagle clips especially designed to probe difficult to reach signal sources, all types of wrapped wiring etc.

Each set contains:

10 eagle clips fitting the probes PM 9335, PM 9336 and PM 9336L
10 adapter pieces fitting the probes PM 9326 and PM 9327
10 adapter pieces fitting the micro-miniature probe PM 9352

Fig. 3.36. Adapter set PM 9333

3.5.8. MULTI-PURPOSE CAMERA PM 9380

Camera PM 9380 has been designed to photograph oscilloscope displays in a quick and simple way.
It incorporates the Polaroid instant photographic process which has the advantage that you can see the picture a few moments after you took it.

Fig. 3.37. Multi-purpose camera PM 9380

3.5.9. ADAPTER PM 9379

This adapter forms the connection between camera PM 9380 and oscilloscope PM 3234. The dimensions of the adapter are such, that the camera automatically focussed when the camera-adapter combination is held against the front of the oscilloscope.

NOTE

Together with this adapter, a supplementary lens PM 9373 must be used.

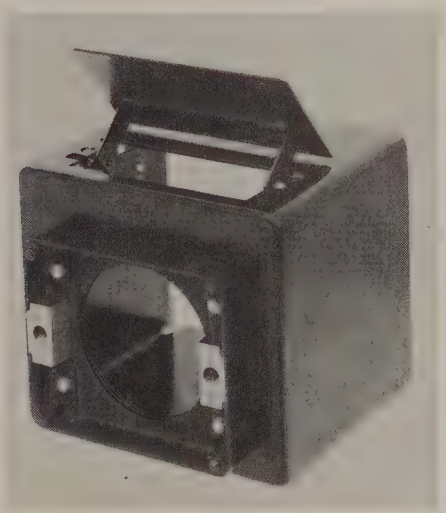


Fig. 3.38. Adapter PM 9379

3.6. Parts lists and diagrams (Subject to alteration without notice)

3.6.1. MECHANICAL PARTS

Item	*Fig.*	*Qty*	*Ordering number*	*Description*
1	3.39	1	5322 268 14052	Calibration terminal BU1 compl.
2	3.39	1	5322 268 10031	Calibration contact pin BU1
3	3.39	1	5322 325 84011	Grommet for BU1
4	3.39	1	5322 492 60799	Spring for BU1
5	3.39	1	5322 532 54198	Insulating ring for BU1
6	3.39	5	5322 414 34119	Control knob (R1, R2, R3, R4, R5)
7	3.39	4	5322 414 74014	Cover for control knob (grey)
8	3.39	3	5322 414 74016	Cover for control knob (blue)
9	3.39	3	5322 414 34081	Switch knob (SK3, SK17, SK18)
10	3.39	10	5322 276 14101	Push-button switch (SK4...SK13)
11	3.39	10	5322 414 24846	Knob for SK4...SK13
12	3.39	1	5322 455 84037	Text plate, front (big)
13	3.39	1	5322 276 10398	Reset pushbutton (compl.)
14	3.39	4	5322 267 10004	BNC socket (BU2, BU3, BU5, BU6)
15	3.39	4	5322 506 14001	Nut for BNC socket
16	3.39	3	5322 532 24319	Padding ring for BU2, BU3, BU5
17	3.39	2	5322 276 14103	Push-button switch (SK14, SK15)
18	3.39	2	5322 414 24845	Knob for SK14, SK15
19	3.39	2	5322 277 14047	Lever switch (SK16, SK19)
20	3.39	2	5322 414 25052	Knob for SK16 and SK19
21	3.39	1	5322 498 54046	Carrying handle
22	3.39	2	5322 500 14152	Screw for carr. handle
23	3.39	1	5322 462 54067	Tilting-bracket
24	3.39	2	5322 462 44067	Hinge for tilting-bracket
25	3.39	4	5322 462 40252	Foot
26	3.39	1	5322 535 80523	Earthing terminal (BU4)
27	3.39	1	5322 505 14178	Nut for BU4
28	3.39	2	5322 414 34108	Control knob (R11, R12)
29	3.39	2	5322 492 64377	Claming spring for R11, R12
30	3.39	3	5322 414 34075	Control knob (R8, R9, R10)
31	3.39	3	5322 414 74015	Cover for control knob (R8, R9, R10)
32	3.39	3	5322 414 74028	Nut cover (R8, R9, R10)
33	3.39	4	5322 276 14102	Push-button switch (SK22...SK25)
34	3.39	1	5322 414 24911	Knob (red)
35	3.39	3	5322 414 14011	Knob (grey)
36	3.39	1	5322 381 10152	Lens
37	3.39	1	5322 455 84036	Text plate front (small)
38	3.39	1	5322 450 14002	Graticule
39	3.39	1	5322 480 34034	Contrast filter (grey)
39	3.39	1	5322 480 34043	Contrast filter (amber)
40	3.39	1	5322 450 14002	Transparent plate
41	3.39	1	5322 447 94228	Mask
42	3.39	1	5322 451 34002	Bezel
43	3.39	1	5322 447 94186	Cabinet plate (top)
44	3.39	1	5322 447 94167	Cabinet plate (bottom)
45	3.40-.41	2	5322 459 84004	Insert

Item	*Fig.*	*Qty*	*Ordering number*	*Description*
46	3.40	1	5322 105 34009	Time-base switch, complete (SK2)
47	3.40	108	5322 255 40089	Transistor socket
48	3.40	6	5322 255 40038	Transistor socket
49	3.40	2	5322 492 64452	Fixing spring (magnet)
50	3.40	2	5322 526 24026	Cylindrical magnet
51	3.40	1	5322 255 70159	Valve socket for CRT
52	3.40	1	5322 466 85168	Earthing terminal
53	3.40	1	5322 405 94046	Clamp for earthing terminal
54	3.40	1	5322 267 40127	Socket 6 cont. (BU8)
55	3.40	1	5322 256 34019	Fuse holder
56	3.40	1	5322 455 84038	Text plate, rear
57	3.40	1	4822 272 10079	Voltage adaptor
58	3.41	2	5322 105 34008	Attenuator switch, complete (SK17, SK18)
59	3.41	2	5322 532 34079	Coupling piece for R4, R5
60	3.41	2	5322 462 70715	Plastic cap
61	3.41	2	5322 255 44053	S Clip (non-insulated)
61	3.41	2	5322 255 40106	S Clip (insulated)
62	3.41	1	5322 321 14001	Mains flex
63	3.41	2	5322 532 24321	Coupling piece for R8, R9
64	3.41	3	5322 255 24015	Lamp holder for La1
65	3.42	1	5322 447 94091	Front cover
66	3.42	1	5322 414 34086	Key
67	3.42	1	5322 492 54152	Compression spring
68	3.42	1	4822 530 70126	Fixing spring (Front cover)
69	3.42	1	5322 455 84009	Plate
70	3.40	1	5322 216 54107	Printed wiring board of power supply unit, complete with components
71	3.40	1	5322 216 54105	Automatic brightness cont. unit
72	3.40	1	5322 216 54108	Printed wiring board of time-base unit, complete with components (incl. time-base switch)
73	3.41	1	5322 216 54132	Delay line unit
74	3.41	1	5322 216 54131	Printed wiring board of vertical amplifier unit, complete with components (incl. att. switches, delay line unit and delay line)
75	3.41	1	5322 216 54109	High tension unit
76	3.41	1	5322 216 54104	C.R.T. adjustment unit
77	3.41	1	5322 216 54106	Storage unit

3.6.1.1. Miscellaneous parts

Item	*Ordering number*	*Description*
B1	5322 131 24027	C.R.T. type L14-130 GH/55
LA1	5322 134 40268	Lamp 28 V, 40 mA (Type 387)
LA4	4822 134 40167	Lamp 5 V, 60 mA
VL1	4822 253 30016	Fuse 400 mA delayed action
VL802	4822 253 30022	Fuse, 1.25 A delayed action
T801	5322 146 14081	Mains transformer

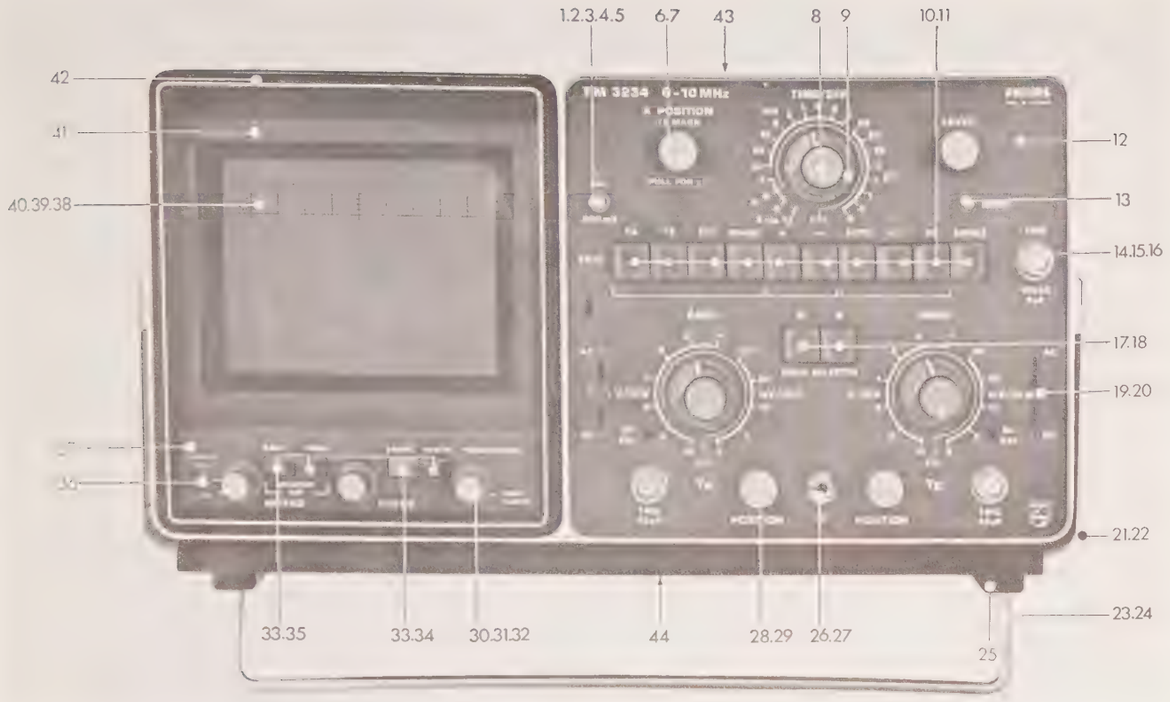


Fig. 3.39. Front view showing item numbers

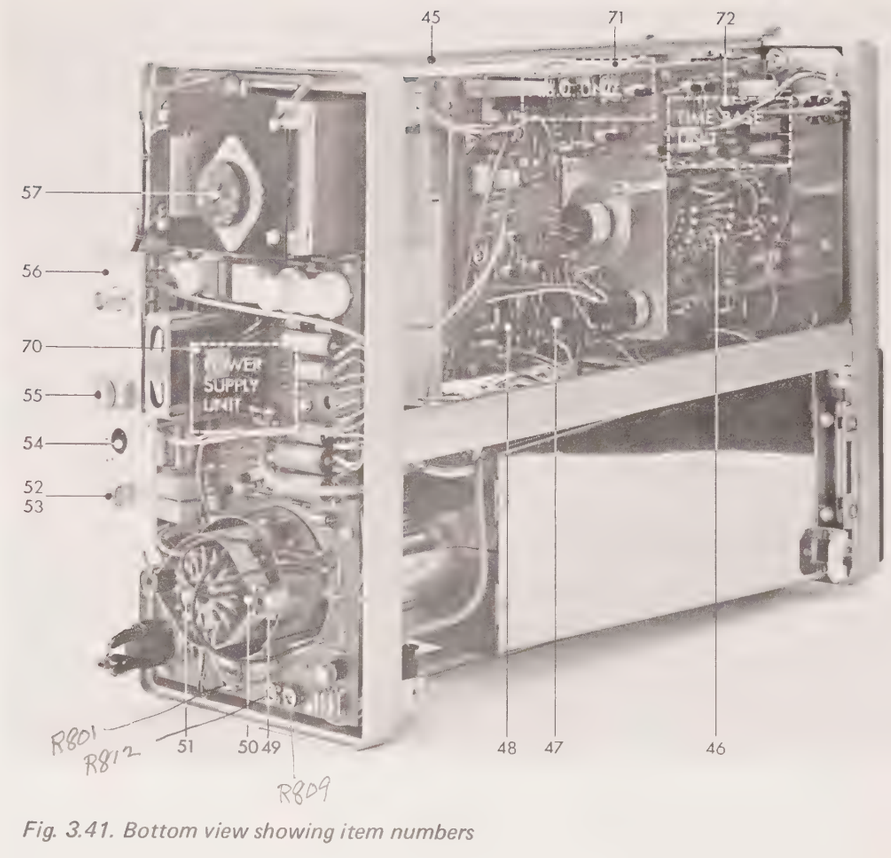


Fig. 3.41. Bottom view showing item numbers

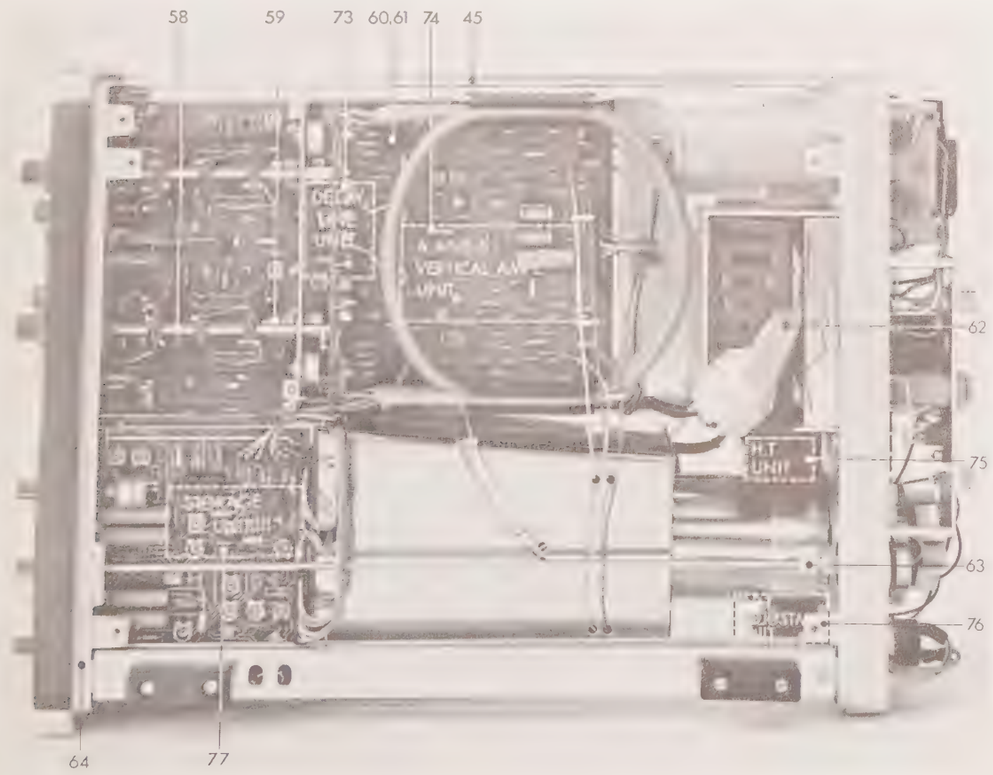


Fig. 3.40. Top and rear view showing item numbers

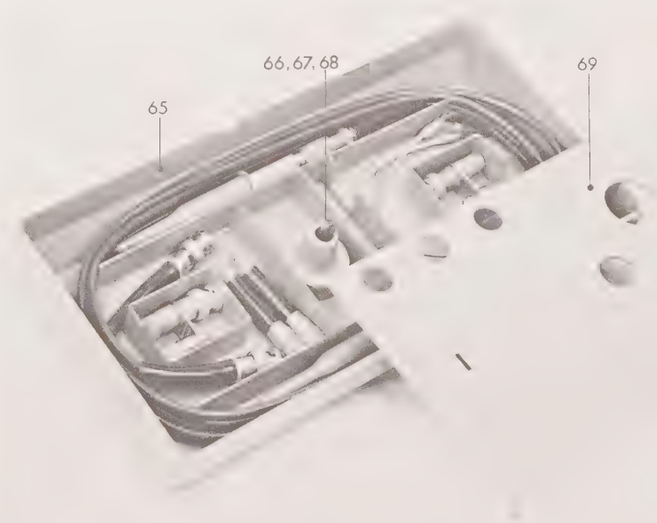


Fig. 3.42. Front cover showing item numbers

3.6.2. ELECTRICAL PARTS

3.6.2.1. Capacitors

Item	Ordering number	Farad	Tol. (%)	Volts
C26	4822 121 40149	100N	10	630
C28	5322 125 54027	5,5P		400
C29	5322 125 54027	5,5P		400
C30	4822 122 31191	5,6P	2	500
C31	4822 122 31202	33P	2	500
C32	4822 122 31187	2,7P	0,25P	500
C33	5322 125 54027	5,5P		400
C34	5322 125 54027	5,5P		400
C35	4822 122 31217	3,9P	0,25P	500
C36	4822 121 50418	390P	5	250
C37	4822 121 41161	100N	10	250
C38	4822 122 31191	5,6P	2	500
C50	4822 122 31081	100P	2	100
C51	5322 121 54086	82P	1	500
C52	5322 125 54026	3P		400
C53	4822 122 31067	33P	2	100
C54	4822 121 41152	47N	10	250
C55	4822 121 41152	47N	10	250
C56	4822 122 31172	180P	10	100
C57	4822 124 20468	33M		16
C58	4822 124 20453	68M		6,3
C59	4822 121 41134	10N	10	250
C60	4822 121 41152	47N	10	250
C61	4822 124 20468	33M		16
C62	4822 125 50045	22P		100
C63	4822 121 41152	47N	10	250
C64	4822 122 31178	680P	10	100
C66	4822 122 31178	680P	10	100
C67	4822 122 31072	47P	2	63
C68	4822 122 31175	1N	10	100
C69	4822 122 31081	100P	2	63
C73	4822 122 31215	0,68P	0,25P	63
C74	4822 122 31215	0,68P	0,25P	63
C76	4822 122 31215	0,68P	0,25P	63
C77	4822 122 31215	0,68P	0,25P	63
C78	4822 122 31215	0,68P	0,25P	63
C79	4822 122 31215	0,68P	0,25P	63
C80	4822 121 41152	47N	10	250
C81	4822 121 41152	47N	10	250
C82	4822 124 20471	220M		16
C83	4822 121 40104	150N	10	250
C84	4822 121 41152	47N	10	250
C226	4822 121 40149	100N	10	630
C228	5322 125 54027	5,5P		400
C229	5322 125 54027	5,5P		400
C230	4822 122 31191	5,6P	2	500
C231	4822 122 31202	33P	2	500
C232	4822 122 31187	2,7P	0,25P	500
C233	5322 125 54027	5,5P		400
C234	5322 125 54027	5,5P		400
C235	5322 125 54027	5,5P		400
C236	4822 121 50418	390P	5	250
C237	4822 121 41161	100N	10	250
C238	4822 122 31191	5,6P	2	500
C250	4822 122 31074	56P	2	100
C251	5322 121 54086	82P	1	500
C252	5322 125 54027	5,5P		400
C253	4822 122 31067	33P	2	100
C256	4822 122 31172	180P	10	100
C257	4822 124 20468	33M		16
C258	4822 124 20469	68M		6,3
C259	4822 121 41134	10N	10	250
C261	4822 124 20468	33M		16
C262	4822 125 50045	22P		100
C263	4822 121 41152	47N	10	250
C264	4822 122 31178	680P	10	100
C266	4822 122 31178	680P	10	100
C267	4822 122 31072	47P	2	100
C273	4822 122 31215	0,68P	0,25P	100
C274	4822 122 31215	0,68P	0,25P	100
C276	4822 122 31215	0,68P	0,25P	100
C277	4822 122 31215	0,68P	0,25P	100
C278	4822 122 31215	0,68P	0,25P	100
C279	4822 122 31215	0,68P	0,25P	100
C281	4822 121 41152	47N	10	250
C282	4822 124 20471	220M		16
C283	4822 124 20527	470M		25
C284	4822 121 41134	10K	10	250
C285	4822 124 20467	15M		16
C286	4822 121 41152	47N	10	250
C400	4822 122 30045	27P	2	100
C401	4822 120 11027	1P	0,25P	500
C402	4822 121 41152	47N	10	250
C403	4822 121 41152	47N	10	250
C404	4822 122 30114	2,2N	10	100
C405	4822 121 41152	47N	10	250
C406	4822 121 40197	1M	10	100
C407	4822 121 41152	47N	10	250
C408	4822 121 40186	470N	10	250
C409	4822 121 40186	470N	10	250
C410	4822 124 20466	4,7M		16
C415	4822 121 41152	47N	10	250
C416	4822 124 20467	15M		16
C417	4822 121 41152	47N	10	250
C501	4822 122 31067	33P	2	100
C502	4822 122 31067	33P	2	100
C503	4822 122 31067	33P	2	100
C504	4822 122 31058	15P	2	100
C505	4822 121 41152	47N	10	250
C506	4822 124 20466	4,7M		16
C507	4822 122 31166	560P	10	100
C508	4822 121 41152	47N	10	250
C509	4822 122 31175	1N	10	100
C510	4822 122 31063	22P	2	100
C511	4822 122 31221	1,5N	10	100
C513	4822 124 20468	33M		16
C514	4822 124 20468	33M		16
C516	4822 124 20468	33M		16
C521	4822 121 40266	4,7M	10	100
C522	4822 121 50564	510P	1	250
C523	4822 121 50543	5,6N	1	63
C524	4822 124 20584	2,2M		63
C526	4822 121 50566	1N	5	125
C601	4822 122 30092	180P	2	100
C602	4822 122 31175	1N	10	100
C603	4822 122 31052	8,2P	0,25P	63
C604	4822 121 41152	47N	10	250
C606	4822 124 20468	33M		16
C607	4822 121 41152	47N	10	250
C608	4822 124 20467	15M		16
C609	4822 124 20467	15M		16
C702	4822 124 20467	15M		16
C703	4822 121 41138	15N	10	250
C704	4822 121 40104	150N	10	250
C706	4822 121 40253	1N	10	1600
C707	4822 121 40253	1N	10	1600

Item	Ordering number	Farad	Tol. (%)	Volts
C708	4822 122 30045	27P	2	100
C709	4822 121 40253	1N	10	1600
C710	4822 121 41152	47N	10	250
C750	4822 121 41147	33N	10	250
C751	4822 121 41143	22N	10	250
C752	4822 121 41161	100N	10	250
C753	4822 124 20475	10M		25
C754	4822 124 20467	15M		16
C756	4822 122 31175	1N	10	100
C801	4822 121 41152	47N	10	250
C802	4822 121 41134	10N	10	630
C804	4822 121 41152	47N	10	250
C805	4822 121 41152	47N	10	250
C806	4822 122 30103	22N	+20+80%40	
C807	4822 121 41152	47N	10	250
C808	4822 122 30103	22N	+20+80%40	
C809	4822 122 30103	22N	+20+80%40	
C810	5322 121 44109	100N	20	250
C811	4822 121 40197	1M	10	100
C812	4822 121 40197	1M	10	100
C813	4822 124 20492	1,5M		63
C814	4822 124 20492	1,5M		63
C815	4822 121 41161	100N	10	250
C816	4822 121 41161	100N	10	250
C817	4822 124 70319	2X3400M		40
C818	4822 124 20453	68M		6,3
C819	4822 124 20453	68M		6,3
C820	4822 121 41161	100N	10	250
C821	4822 121 41134	10N	10	630
C822	5322 122 54004	470P	20	4000
C823	5322 122 54004	470P	20	4000
C825	4822 124 20462	100M		10
C826	4822 121 40196	22N	10	1600
C827	4822 121 40196	22N	10	1600
C828	4822 124 20313	10M		200
C829	4822 124 20305	32M		100
C830	4822 124 20485	33M		40
C831	4822 124 20527	470M		25
C832	4822 124 20468	33M		16
C833	4822 124 20471	220M		16
C834	4822 124 20468	33M		16
C836	4822 124 20471	220M		16
C837	5322 122 54004	470P	20	4000
C838	5322 122 54004	470P	20	4000
C839	5322 122 24001	600P	20	10000
C841	4822 124 20518	1000M		10
C842	4822 124 20518	1000M		10
C901	4822 125 50045	22P		100
C902	4822 125 50045	22P		100
C903	4822 122 31173	220P		100
C904	4822 121 41134	10N		250
C906	4822 122 31177	470P		100
C907	4822 124 20483	6,8M		40
C908	4822 121 41152	47N		250
C1001	4822 125 50045	22P		100
C1002	4822 125 50045	22P		100
C1003	4822 122 31173	220P		100
C1004	4822 121 41134	10N		250
C1006	4822 122 31177	470P		100
C1007	4822 120 11054	10P	5	500
C1010	4822 124 20468	33M		16
C1011	4822 121 41134	10N	10	250
C1012	4822 121 41152	47N	10	250
C1013	5322 121 40197	1M	10	100
C1014	4822 122 30103	22N	+20+80%40	
C1015	4822 124 20582	47M		4
C1016	4822 121 40257	330N	10	100
C1017	4822 121 41161	100N	10	250
C1018	4822 122 30103	22N	+20+80%40	

Item	Ordering number	Farad	Tol. (%)	Volts
C1019	4822 121 41161	100N	10	250
C1020	4822 122 30103	22N	+20+80%40	
C1021	4822 121 41152	47N	10	250
C1022	4822 121 41152	47N	10	250
C1023	4822 122 30103	22N	+20+80%40	
C1024	4822 124 20453	68M		6,3
C1025	4822 124 20453	68M		6,3
C1026	4822 122 31174	2,7N	10	100
C1027	4822 124 20452	33M		6,3
C1028	4822 124 20605	1,5M		63

Item	Ordering number	Type/description
3.6.2.2. Diodes		
GR53	5322 130 34037	BAV45
GR54	5322 130 30759	BZX79-C5V6
GR56	5322 130 30766	BZX79-C6V2
GR57	5322 130 30766	BZX79-C6V2
GR58	5322 130 30766	BZX79-C6V2
GR253	5322 130 34037	BAV45
GR254	5322 130 30759	BZX79-C5V6
GR257	5322 130 30766	BZX79-C6V2
GR401	5322 130 40182	BAX13
GR402	5322 130 40182	BAX13
GR403	5322 130 30759	BZX79-C5V6
GR404	5322 130 30231	AAZ13
GR406	5322 130 30231	AAZ13
GR408	5322 130 34069	BZX79-C12
GR409	5322 130 40182	BAX13
GR500	5322 130 40182	BAX13
GR501	5322 130 30231	AAZ13
GR502	5322 130 40182	BAX13
GR503	5322 130 40182	BAX13
GR504	5322 130 40182	BAX13
GR506	5322 130 30273	BAX16
GR702	5322 130 30273	BAX16
GR751	5322 130 34167	BZX79-B6V2
GR801	5322 130 34076	BZX79-C18
GR803	5322 130 30414	BY164 2XPAR
GR808	5322 130 30759	BZX79-C5V6
GR809	5322 130 34049	BZX75-C2V1
GR810	5322 130 30424	BAX12
GR811	5322 130 30759	BZX79-C5V6
GR812	5322 130 30424	BAX12
GR814	5322 130 34136	BY187
GR816	5322 130 34136	BY187
GR817	5322 130 34136	BY187
GR818	4822 130 30839	BA148
GR819	5322 130 30605	BAX17
GR820	4822 130 30839	BA148
GR821	5322 130 30424	BAX12
GR822	5322 130 30424	BAX12
GR823	5322 130 30424	BAX12
GR824	5322 130 30424	BAX12
GR826	5322 130 30424	BAX12
GR827	5322 130 30424	BAX12
GR828	5322 130 30605	BAX17
GR829	4822 130 30839	BA148
GR831	5322 130 34275	BYX71-350R
GR832	5322 130 34136	BY187
GR833	5322 130 34136	BY187
GR834	5322 130 34275	BYX55
GR901	5322 130 34174	BZX79-B4V7

Item	Ordering number	Type/description
GR1001	5322 130 34174	BZX79-B4V7
GR1011	5322 130 40182	BAX13
GR1012	5322 130 30605	BAX17
GR1013	5322 130 30651	BZX61-C51
GR1014	5322 130 30605	BAX17
GR1016	4822 130 30839	BY206
GR1017	5322 130 40182	BAX13
GR1018	5322 130 34413	BZX61-C16
GR1019	5322 130 40182	BAX13
GR1021	5322 130 30264	BZX79-C4V7
GR1024	5322 130 40182	BAX13
GR1026	5322 130 40182	BAX13
GR1027	5322 130 40182	BAX13
GR1028	5322 130 40182	BAX13
GR1029	5322 130 34119	BZX79-C8V2
GR1031	5322 130 40182	BAX13
GR1033	5322 130 40182	BAX13
GR1034	5322 130 30264	BZX79-C4V7
GR1036	5322 130 40182	BAX13
GR1037	5322 130 40182	BAX13
GR1038	5322 130 40182	BAX13
GR1039	5322 130 40182	BAX13

3.6.2.3. Integrated circuits

IC1001	5322 209 84386	TCA220
IC1002	5322 209 84379	FZH181
IC1003	5322 209 84512	SN7426N-00T1

3.6.2.4. Coils

L401	5322 158 10308	COIL 68MUH
L800	5322 158 10276	COIL 4,7MUH
L801	5322 156 34009	COIL
L802	5322 142 64028	CONVERTER-COIL
L803	4822 157 50308	CHOKE
L804	4822 157 50308	CHOKE
L805	5322 158 10308	COIL 68MUH
L806	4822 157 50308	CHOKE

Item	Ordering number	Ohm	Tol. (%)	Type
3.6.2.5. Resistors				
R1	5322 101 64003	2,2K	20	0,25W
R2	5322 101 44005	10K	20	0,25W
R3	4822 102 30177	2X47K	20	0,1W
R4	4822 101 20455	1K	20	0,1W
R5	4822 101 20455	1K	20	0,1W
R6	4822 101 20289	22K	20	0,1W
R7	4822 101 20289	22K	20	0,1W
R8	4822 101 40061	22K	20	0,25W
R9	5322 101 24032	470K4K7		0,25W
R10	5322 101 44018	10K	20	0,25W
R11	5322 101 24045	1K	20	CP23
R12	5322 101 24045	1K	20	CP23
R26	4822 110 63072	47	5	CR25
R27	5322 116 54212	900K	1	MR30
R28	4822 110 63072	47	5	MR25
R29	5322 116 54213	111K	1	MR30
R32	5322 116 54209	992K	1	MR30
R33	5322 116 54211	10,1K	1	MR30
R36	5322 116 54858	156	0,25	MR34C
R37	5322 116 54273	437	0,25	MR34C
R38	5322 116 50486	1,11K	0,25	MR34C
R39	5322 116 50385	4,27K		MR34C
R40	5322 116 50289	348	0,25	MR34C
R41	5322 116 54274	898	0,25	MR34C
R42	5322 116 54275	1,89K	0,25	MR34C
R43	5322 116 54276	17,2K	0,25	MR34C
R44	5322 116 50552	4,27K	0,25	MR34C
R51	5322 116 54749	90,9K	1	MR30
F52	5322 116 54408	909K	1	MR30
R53	4822 110 63072	47	5	CR25
R54	4822 110 63072	47	5	CR25
R56	4822 110 63072	47	5	CR25
R57	4822 110 63103	680	5	CR25
R58	4822 110 63127	5,6K	5	CR25
R59	4822 110 63072	47	5	CR25
R60	4822 110 63129	6,8K	5	CR25
R61	4822 110 63132	8,2K	5	CR25
R62	5322 116 54277	4,93K	0,25	MR34C
R63	4822 110 63094	330	5	CR25
R64	4822 100 10038	470	2	0,1W
R65	4822 110 63056	12	5	CR25
R66	4822 110 60077	75	5	CR25
R67	4822 110 63132	8,2	5	CR25
R68	5322 116 34011	33	10	0,5W
R69	4822 110 63081	100	5	CR25
R71	4822 110 63134	10K	5	CR25
R72	4822 110 63134	10K	5	CR25
R73	4822 110 63085	150	5	CR25
R74	4822 110 60115	2K	5	CR25
R75	4822 110 63121	3,3K	5	CR25
R76	4822 110 63161	100K	5	CR25
R77	4822 110 63072	47	5	CR25
R78	4822 110 63116	2,2K	5	CR25
R81	4822 110 53129	6,8K	5	CR37
R82	4822 110 53129	6,8K	5	CR37
R83	4822 110 63094	330	5	CR25
R84	4822 110 53127	5,6K	5	CR37
R85	4822 116 20063			VDR
R86	4822 110 63083	120	5	CR25
R87	4822 110 53127	5,6K	5	CR37
R88	4822 110 63127	5,6K	5	CR25
R89	4822 110 63103	680	5	CR25
R91	4822 110 63089	220	5	CR25
R92	4822 110 63121	3,3K	5	CR25
R93	4822 110 60115	2K	5	CR25
R94	4822 100 10038	470	20	0,1W
R95	4822 110 63081	100	5	CR25
R96	4822 110 60131	7,5K	5	CR25
R97	5322 116 54855	5,36K	1	MR30

Item	Ordering number	Ohm	Tol. (%)	Type
R98	4822 110 63072	47	5	CR25
R99	4822 100 10038	470	20	0.1W
R100	4822 110 63081	100	5	CR25
R101	5322 116 54595	5.11K	1	MR25
R102	5322 116 54255	17.4K	0.25	MR34C
R103	4822 110 60099	510	5	CR25
R104	4822 110 63107	1K	5	CR25
R106	4822 110 53072	47	5	CR37
R107	5322 116 54587	3.65K	1	MR25
R108	4822 110 63096	390	5	CR25
R109	5322 116 54567	3.65K	1	MR25
R111	5322 101 14058	470	20	0.1W
R112	4822 110 60091	270	5	CR25
R113			5	CR25
R114	4822 110 63152	47K	5	CR25
R116	4822 110 63107	1K	5	CR25
R117	4822 110 63152	47K	5	CR25
R118	4822 110 63096	390	5	CR25
R119	4822 110 63107	1K	5	CR25
R121	4822 110 63134	10K	5	CR25
R122	4822 110 42214	10M	5	VR37
R123	4822 110 42207	5.6M	5	VR37
R124	4822 110 63132	8.2K	5	CR25
R125	4822 110 63116	2.2K	5	CR25
R126	4822 100 10038	470	20	0.1W
R127	4822 110 42214	10M	5	VR37
R128	5322 116 54408	909K	1	MR30
R129	4822 110 42214	10M	5	VR37
R130	4822 110 63141	18K	5	CR25
R131	4822 110 60179	510K	5	CR25
R132	4822 110 53127	5.6K	5	CR37
R133	4822 110 53127	5.6K	5	CR37
R134	4822 110 63083	120	5	CR25
R135	4822 116 20063			VDR
R136	4822 110 63094	330	5	CR25
R137	4822 110 53129	6.8K	5	CR37
R138	4822 110 53129	6.8K	5	CR37
R142	4822 110 63054	10	5	CR25
R143	4822 110 63043	3.9	5	CR25
R144	4822 110 63103	680	5	CR25
R145	4822 110 63072	47	5	CR25
R146	4822 110 63103	680	5	CR25
R147	4822 110 63103	680	5	CR25
R226	4822 110 63072	47	5	CR25
R227	5322 116 54212	900K	1	MR30
R228	4822 110 63072	47	5	CR25
R229	5322 116 54213	111K	1	MR30
R232	5322 116 54209	992K	1	MR30
R233	5322 116 54211	10.1K	1	MR30
R236	5322 116 54858	156	0.25	MR34C
R237	5322 116 54273	437	0.25	MR34C
R238	5322 116 50486	1.11K	0.25	MR34C
R239	5322 116 50385	4.75K	0.25	MR34C
R240	5322 116 50289	348	0.25	MR34C
R241	5322 116 54274	898	0.25	MR34C
R242	5322 116 54275	1.89K	0.25	MR34C
R243	5322 116 54276	17.2K	0.25	MR34C
R244	5322 116 50552	4.27K		MR34C
R251	5322 116 54749	90.9K	1	MR30
R252	5322 116 54408	909K	1	MR30
R253	4822 110 63072	47	5	CR25
R254	4822 110 63072	47	5	CR25
R256	4822 110 63072	47	5	CR25
R257	4822 110 63103	680	5	CR25
R258	4822 110 63127	5.6K	5	CR25
R259	4822 110 63072	47K	5	CR25
R261	4822 110 63132	8.2K	5	CR25
R262	5322 116 54277	4.93K	0.25	MR34C
R263	4822 110 63094	330	5	CR25
R264	4822 100 10038	470	20	0.1W
R265	4822 110 63163	12	5	CR25
R266	4822 110 60077	75	5	CR25
R267	4822 110 63132	8.2K	5	CR25
R268	5322 116 34011	33	10	0.5W
R272	4822 110 63116	2.2K	5	CR25
R276	4822 110 63161	100K	5	CR25
R277	4822 110 63072	47	5	CR25
R278	4822 110 60115	2K	5	CR25
R280	4822 110 63085	150	5	CR25
R281	4822 110 53129	6.8K	5	CR37
R282	4822 110 53129	6.8K	5	CR37
R283	4822 110 60093	300	5	CR25
R284	4822 110 53127	5.6K	5	CR37
R285	4822 116 20063			VDR
R286	4822 110 63083	120	5	CR25
R287	4822 110 53127	5.6K	5	CR37
R288	4822 110 63127	5.6K	5	CR25
R289	4822 110 63103	680	5	CR25
R291	4822 110 63089	220	5	CR25
R292	4822 110 63121	3.3K	5	CR25
R293	4822 110 60115	2K	5	CR25
R294	4822 100 10038	470	20	0.1W
R295	4822 110 63069	30	5	CR25
R296	4822 110 60131	7.5K	5	CR25
R297	5322 116 54855	5.36K	1	MR30
R298	4822 110 63072	47	5	CR25
R299	4822 100 10038	470	20	0.1W
R300	4822 110 63081	100	5	CR25
R301	5322 116 54595	5.11K	1	MR25
R302	5322 116 54255	17.4K	0.25	MR34C
R303	4822 110 60099	510	5	CR25
R306	4822 110 63072	47	5	CR25
R307	5322 116 54587	3.65K	1	MR25
R308	4822 110 63096	390	5	CR25
R309	5322 116 54587	3.65K	1	MR25
R311	5322 101 14058	470	20	0.1W
R312	4822 110 63092	270	5	CR25
R313			5	CR25
R314	4822 110 63152	47K	5	CR25
R316	4822 110 63107	1K	5	CR25
R317	4822 110 63152	47K	5	CR25
R318	4822 110 63096	390	5	CR25
R319	4822 110 63107	1K	5	CR25
R321	4822 110 63134	10K	5	CR25
R322	4822 110 42214	10M	5	VR37
R323	4822 110 42207	5.6M	5	VR37
R324	4822 110 63132	8.2K	5	CR25
R326	4822 100 10038	470	20	0.1W
R327	4822 110 42214	10M	5	VR37
R328	5322 116 54408	909K	1	MR30
R329	4822 110 42214	10M	5	VR37
R331	4822 110 60179	510K	5	CR37
R332	4822 110 53127	5.6K	5	CR37
R333	4822 110 53127	5.6K	5	CR37
R334	4822 110 63083	120	5	CR25
R335	4822 116 20063			VDR
R336	4822 110 60093	300	5	CR25
R337	4822 110 53129	6.8K	5	CR37
R338	4822 110 53129	6.8K	5	CR37
R339	4822 110 63043	3.9	5	CR25
R341	4822 110 63081	100	5	CR25
R342	4822 110 63054	10	5	CR25
R345	4822 110 63072	47	5	CR25
R346	4822 110 63103	680	5	CR25
R400	4822 110 63196	2.2M	10	CR25
R401	5322 116 54694	91K	5	CR37
R402	4822 110 63134	10K	5	CR25
R403	5322 116 54595	5.11K	1	MR25
R404	5322 116 54603	6.49K	1	MR25
R405	4822 110 63072	47	5	CR25
R406	4822 110 63098	470	5	CR25

Item	Ordering number	Ohm	Tol. (%)	Type
R407	4822 110 63098	470	5	CR25
R408	4822 110 63132	8,2K	5	CR25
R409	4822 110 60124	4,3K	5	CR25
R410	4822 110 63134	10K	5	CR25
R411	4822 110 63125	4,7K	5	CR25
R412	4822 110 60117	2,4K	5	CR25
R413	4822 110 60108	1,1K	5	CR25
R414	4822 100 10038	470	20	0,1W
R415	4822 110 63116	2,2K	5	CR25
R416	4822 110 63098	470	5	CR25
R418	4822 110 60142	20K	5	CR25
R419	4822 110 63072	47	5	CR25
R420	4822 110 63072	47	5	CR25
R421	4822 110 63081	100	5	CR25
R422	4822 110 63081	100	5	CR25
R423	4822 110 63109	1,2K	5	CR25
R424	4822 100 10029	2,2K	20	0,1W
R426	4822 110 63105	820		CR25
R427	4822 110 63072	47	5	CR25
R428	4822 110 63145	27K	5	CR25
R429	4822 110 63107	1K	5	CR25
R431	4822 110 63072	47	5	CR25
R432	4822 110 63152	47K	5	CR25
R433	4822 110 63143	22K	5	CR25
R434	4822 110 63125	4,7K	5	CR25
R436	4822 110 63143	22K	5	CR25
R440	4822 110 63027	1	5	CR25
R443	4822 110 63072	47	5	CR25
R447	4822 110 63114	1,8K	5	CR25
R448	4822 110 60097	430	5	CR25
R449	4822 110 63072	47	5	CR25
R501	5322 116 54426	121	1	MR25
R502	5322 116 54005	3,32K	1	MR25
R503	4822 110 60086	160	5	CR25
R504	4822 110 63072	47	5	CR25
R506	5322 116 54557	1,21K	1	MR25
R507	5322 116 54619	10K	1	MR25
R508	4822 110 60091	240	5	CR25
R509	5322 116 54534	681	1	MR25
R511	5322 116 50608	6,19K	1	MR25
R512	4822 110 63109	1,2K	5	CR25
R513	4822 110 63121	3,3K	5	CR25
R514	4822 110 63107	1K	5	CR25
R516	5322 116 50524	3,01K	1	MR25
R517	5322 116 54627	13,3K	1	MR25
R518	4822 110 63129	6,8K	5	CR25
R519	4822 110 63156	68K	5	CR25
R521	4822 110 63116	2,2K	5	CR25
R522	4822 110 63081	100	5	CR25
R524	4822 110 63116	2,2K	5	CR25
R526	4822 110 63098	470	5	CR25
R527	4822 110 63134	10K	5	CR25
R528	4822 110 60157	75K	5	CR25
R529	4822 110 63094	330	5	CR25
R530	4822 110 63072	47	5	CR25
R531	4822 110 63103	680	5	CR25
R532	4822 116 30018	1,3K	20	1W
R533	4822 110 63121	3,3K	5	CR25
R534	4822 100 10029	2,2K	20	0,1W
R536	4822 110 60126	5,1K	5	CR25
R537	4822 110 63132	8,2K	5	CR25
R538	4822 110 60128	6,2K	5	CR25
R539	4822 100 10051	22K	20	0,1W
R541	4822 110 63072	47	5	CR25
R542	4822 110 63081	100	5	CR25
R543	4822 110 63089	180	5	CR25
R544	4822 110 63081	100	5	CR25
R547	4822 110 63101	560	5	CR25
R549	4822 110 63094	330	5	CR25
R551	4822 110 63134	10K	5	CR25

Item	Ordering number	Ohm	Tol. (%)	Type
R552	4822 110 63127	5,6K	5	CR25
R553	4822 100 10029	2,2K	20	0,1W
R554	4822 110 63136	12K	5	CR25
R556	4822 110 63072	47	5	CR25
R557	4822 110 63107	1K	5	CR25
R558	4822 110 53107	1K	5	CR37
R559	4822 110 63125	4,7K	5	CR25
R561	4822 110 63063	22	5	CR25
R562	4822 110 63063	22	5	CR25
R563	4822 110 63063	22	5	CR25
R565	4822 110 63107	1K	5	CR25
R566	5322 116 54278	576K	1	MR30
R567	5322 116 54729	226K	1	MR25
R568	5322 116 54279	115K	1	MR25
R569	5322 116 54676	56,2K	1	MR25
R570	4822 110 63072	47	5	CR25
R571	5322 116 50481	22,6K	1	MR25
R572	5322 116 50668	11,3K	1	MR25
R573	5322 116 54011	5,62K	1	MR25
R574	5322 116 54574	2,21K	1	MR25
R576	5322 116 50842	1,1K	1	MR25
R601	4822 100 10037	1K	20	0,1W
R602	4822 110 63112	1,5K	5	CR25
R603	4822 110 63081	100	5	CR25
R604	4822 110 60119	3K	5	CR25
R606	4822 110 63132	8,2K	5	CR25
R607	4822 110 63136	12K	5	CR25
R609	4822 110 63156	68K	5	CR25
R610	4822 110 63116	2,2K	5	CR25
R611	4822 110 63072	47	5	CR25
R612	4822 110 60106	910	5	CR25
R613	4822 110 63134	10K	5	CR25
R614	4822 110 63114	1,8K	5	CR25
R615	4822 110 60119	3K	5	CR25
R616	4822 110 63072	47	5	CR25
R617	4822 100 10038	470	20	0,1W
R618	4822 100 10035	10K	20	0,1W
R619	4822 110 63156	68K	5	CR25
R621	4822 110 63125	4,7K	5	CR25
R622	4822 110 63129	6,8K	5	CR25
R623	4822 110 63125	4,7K	5	CR25
R624	4822 110 63114	1,8K	5	CR25
R626	4822 110 63134	10K	5	CR25
R627	4822 110 53152	47K	5	CR37
R628	4822 110 53152	47K	5	CR37
R629	4822 116 20063			VDR
R631	4822 110 63105	820	5	CR25
R632	4822 110 63063	22	5	CR25
R633	4822 110 53152	47K	5	CR37
R634	4822 116 20063			VDR
R636	4822 110 63105	820	5	CR25
R637	4822 110 53152	47K	5	CR37
R638	4822 110 63072	47	5	CR25
R639	4822 110 63072	47	5	CR25
R701	4822 110 63134	10K	5	CR25
R704	4822 110 63072	47	5	CR25
R705	4822 110 63072	47	5	CR25
R706	4822 110 60113	1,6K	5	CR25
R707	4822 110 63098	470	5	CR25
R708	4822 110 63134	10K	5	CR25
R709	4822 110 63156	68K	5	CR25
R710	4822 110 63107	1K	5	CR25
R711	4822 100 10029	2,2K	20	0,1W
R712	4822 110 60108	1,1K	5	CR25
R713	4822 110 63187	1M	5	CR25
R714	4822 110 63187	1M	5	CR25
R715	4822 110 63081	100	5	CR25
R716	4822 110 63125	4,7K	5	CR25
R717	4822 110 63147	33K	5	CR25
R718	4822 110 60164	130K	5	CR25
R719	4822 110 63156	68K	5	CR25

Item	Ordering number	Ohm	Tol. (%)	Type
R720	4822 110 63158	82K	5	CR25
R721	4822 116 20063			VDR
R722	4822 110 63094	330	5	CR25
R750	4822 111 30413	2.2K	5	CR25
R751	4822 110 63123	3.9K	5	CR25
R752	4822 110 63114	1.8K	5	CR25
R753	4822 110 63132	8.2K	5	CR25
R754	4822 110 63185	820K	5	CR25
R756	4822 110 63101	560	5	CR25
R757	4822 110 63096	3.9K	5	CR25
R758	4822 110 63092	270	5	CR25
R759	5322 116 54623	11K	1	MR25
R761	4822 100 10037	1K	20	0.1W
R762	5322 116 50842	1.1K	1	MR25
R763	4822 110 63072	47	5	CR25
R764	4822 110 63072	47	5	CR25
R800	4822 110 60175	360K	5	CR25
R801	4822 100 10035	10K	20	0.1W
R802	4822 110 63107	1K	5	CR25
R803	4822 110 42192	1.5M	10	CR68
R804	4822 110 53187	1M	5	CR37
R805	4822 110 60117	2.4K	5	CR25
R806	4822 110 63178	470K	5	CR25
R807	4822 110 42194	1.8M	10	CR68
R809	4822 100 10107	470K	20	0.1W
R810	4822 110 53185	820K	5	CR37
R811	4822 110 63161	100K	5	CR25
R812	4822 100 10107	470	20	0.1W
R813	4822 101 20239	22K	20	0.1W
R815	4822 110 63027	1	5	CR25
R817	4822 110 63143	22K	5	CR25
R818	4822 110 63096	390	5	CR25
R819	4822 110 63121	3.3K	5	CR25
R820	4822 110 63101	560	5	CR25
R821	4822 110 63152	47K	5	CR25
R822	4822 110 63105	820	5	CR25
R823	4822 100 10038	470	20	0.1W
R824	4822 110 63105	820	5	CR25
R825	4822 110 63098	470	5	CR25
R826	4822 110 63114	1.8K	5	CR25
R827	4822 110 63054	10	5	CR25
R828	5322 116 64015	7.5M	5	VR68
R829	4822 110 60144	24K		CR25
R830	4822 110 63134	10K		CR25
R831	4822 110 63098	470		CR25
R832	4822 110 60115	2K		CR25
R833	4822 110 63118	2.7K		CR25
R834	4822 100 10036	4.7K	20	0.1W
R836	4822 110 63118	2.7K	5	CR25
R837	4822 110 63118	2.7K	5	CR25
R838	4822 100 10036	4.7K	20	0.1W
R839	4822 110 63118	2.7K	5	CR25
R841	5322 116 54696	100K	1	MR25
R842	5322 116 50672	51.1K	1	MR25
R843	4822 110 63169	220K	5	CR25
R844	5322 116 54469	100	1	MR25
R846	5322 116 54469	100	1	MR25
R847	4822 100 10036	4.7K	20	0.1W
R848	4822 100 10089	1M	20	0.1W
R849	4822 100 10089	1M	20	0.1W
R851	5322 116 64015	7.5M	5	VR68
R852	4822 110 42187	1M	5	VR37
R901	4822 110 63187	1M	5	CR25
R902	4822 110 63105	820	5	CR25
R903	5322 116 54519	402	1	MR25
R904	5322 116 50555	1.27K	1	MR25
R906	4822 110 63072	47	5	CR25
R907	4822 110 63096	390	5	CR25
R908	4822 110 63105 M	820	5	CR25
R909	4822 110 63098 M	470	5	CR25

Item	Ordering number	Ohm	Tol. (%)	Type
R911	5322 116 54541	825	1	MR25
R912	4822 110 60122	3.6K	5	CR25
R913	4822 110 60093	300	5	CR25
R914	4822 110 60137	13K	5	CR25
R916	5322 116 54484	140	1	MR25
R917	5322 116 54484	140	1	MR25
R918	5322 116 54531	634	1	MR25
R919	4822 110 63072	47	5	CR25
R921	4822 110 63123	3.9K	5	CR25
R922	4822 110 63109	1.2K	5	CR25
R923	5322 116 54585	3.48K	1	MR25
R924	5322 116 50842	1.1K	1	MR25
R1001	4822 110 63187	1M	5	CR25
R1002	4822 110 63105	820	5	CR25
R1003	5322 116 54519	402	1	MR25
R1004	5322 116 50555	1.27K	1	MR25
R1006	4822 110 63072	47	5	CR25
R1007	4822 110 63096	390	5	CR25
R1008	4822 110 63105	820	5	CR25
R1009	4822 110 63098	470	5	CR25
R1011	5322 116 54541	825	1	MR25
R1012	4822 110 60122	3.6K	5	CR25
R1013	4822 110 60093	300	5	CR25
R1014	4822 110 60137	13K	5	CR25
R1016	5322 116 54484	140	1	MR25
R1017	5322 116 54484	140	1	MR25
R1018	5322 116 54531	634	1	MR25
R1019	4822 110 63072	47	5	CR25
R1021	4822 110 63123	3.9K	5	CR25
R1022	4822 110 63109	1.2K	5	CR25
R1023	5322 116 54585	3.48K	1	MR25
R1024	5322 116 50842	1.1K	1	MR25
R1031	4822 100 10036	4.7K	20	0.1W
R1032	4822 110 60146	30K	5	CR25
R1033	4822 110 63196	2.2M	10	CR25
R1034	5322 116 54632	14.7K	1	MR25
R1035	4822 110 63081	100	5	CR25
R1036	5322 116 50482	33.2K	1	MR25
R1037	4822 110 63125	4.7K	5	CR25
R1038	4822 110 63134	10K	5	CR25
R1039	4822 110 60173	300K	5	CR25
R1041	4822 110 60184	750K	5	CR25
R1042	4822 110 63134	10K	5	CR25
R1043	4822 110 63098	470	5	CR25
R1044	4822 100 10036	4.7K	20	0.1W
R1046	4822 110 63125	4.7K	5	CR25
R1047	4822 110 63161	100K	5	CR25
R1048	4822 100 10089	1M	20	0.1W
R1049	4822 110 60146	30K	5	CR25
R1051	4822 100 10088	220K	20	0.1W
R1052	4822 110 60157	75K	5	CR25
R1053	4822 110 63161	100K	5	CR25
R1054	5322 116 54696	100K	1	MR25
R1056	5322 116 50482	33.2K	1	MR25
R1057	5322 116 54608	7.50K	1	MR25
R1058	5322 116 50731	10.5K	1	MR25
R1059	4822 100 10029	2.2K	20	0.1W
R1060	4822 110 63161	100K	5	CR25
R1061	4822 110 63187	1M	5	CR25
R1062	5322 116 50729	4.22K	1	MR25
R1063	5322 116 50747	1K	1	MR25
R1064	5322 116 54519	402	1	MR25
R1066	4822 110 63161	100K	5	CR25
R1067	5322 116 54595	5.11K	1	MR25
R1068	4822 100 10035	10K	20	0.1W
R1069	4822 110 63152	47K	5	CR25
R1071	4822 110 63098	470	5	CR25
R1072	4822 110 63134	10K	5	CR25
R1073	4822 110 60173	300K	5	CR25
R1074	4822 110 60184	750K	5	CR25

Item	Ordering number	Ohm	Tol. (%)	Type
R1076	4822 110 63134	10K	5	CR25
R1077	4822 110 63125	4,7K	5	CR25
R1078	4822 110 63125	4,7K	5	CR25
R1081	4822 110 63114	1,8K	5	CR25
R1082	4822 110 63114	1,8K	5	CR25
R1083	4822 100 10079	47K	20	0,1W
R1084	4822 100 10036	4,7K	20	0,1W
R1086	4822 110 63152	47K	5	CR25
R1087	5322 116 54587	3,65K	1	MR25
R1088	4822 110 63158	82K	5	CR25
R1089	5322 116 54674	53,6K	1	MR25
R1091	4822 110 63163	120K	5	CR25
R1092	4822 110 63156	68K	5	CR25
R1093	5322 116 54619	10K	1	MR25
R1094	5322 116 54629	14K	1	MR25
R1096	4822 110 63072	47	5	CR25
R1097	4822 110 63125	4,7K	5	CR25
R1098	4822 110 60108	1,1K	5	CR25
R1099	4822 110 63125	4,7K	5	CR25
R1101	4822 110 63161	100K	5	CR25
R1102	4822 110 63125	4,7K	5	CR25
R1103	4822 110 63125	4,7K	5	CR25
R1104	4822 110 63125	4,7K	5	CR25
R1106	4822 110 63112	1,5K	5	CR25
R1107	4822 110 63134	10K	5	CR25
R1108	4822 110 63098	470	5	CR25
R1109	4822 110 63125	4,7K	5	CR25
R1111	4822 110 63125	4,7K	5	CR25
R1112	4822 110 63138	15K	5	CR25
R1113	4822 110 63125	4,7K	5	CR25
R1114	4822 110 63132	8,2K	5	CR25
R1116	4822 110 63121	3,3K	5	CR25
R1117	4822 110 63152	47K	5	CR25
R1118	4822 110 63125	4,7K	5	CR25
R1119	4822 110 63125	4,7K	5	CR25
R1121	4822 110 63125	4,7K	5	CR25
R1122	4822 110 53081	100	5	CR37
R1123	4822 110 63163	120K	5	CR25
R1124	4822 110 60159	91K	5	CR25
R1126	4822 110 63161	100K	5	CR25
R1127	4822 110 63141	18K	5	CR25
R1128	4822 110 60142	20K	5	CR25
R1129	4822 110 60175	360K	5	CR25
R1130	4822 100 10076	47K	20	0,1W
R1131	4822 110 63134	10K	5	CR25
R1132	4822 110 60115	2K	5	CR25
R1133	4822 110 60117	2,4K	5	CR25
R1134	4822 110 63152	47K	5	CR25
R1136	4822 110 63161	100K	5	CR25
R1137	4822 110 60131	7,5K	5	CR25
R1138	4822 100 10025	4,7K	20	0,1W
R1139	4822 111 30269	1K	5	CR16

Item	Ordering number	Type/description

3.6.2.6. Transistors

TS51	5322 130 40408	BFW11
TS52	5322 130 44195	BF494
TS53	4822 130 40973	BC557
TS54	5322 130 44154	BF199
TS56	4822 130 40965	BC547
TS57	5322 130 44154	BF199
TS58	5322 130 44154	BF199
TS59	5322 130 44154	BF199
TS61	5322 130 44195	BF494
TS62	5322 130 40408	BFW11
TS63	5322 130 40373	BCY71
TS64	5322 130 40324	BCY70
TS66	4822 130 40964	BC549
TS67	4822 130 40964	BC549
TS68	5322 130 44154	BF199
TS69	5322 130 44154	BF199
TS71	5322 130 40144	BC109C
TS72	5322 130 40144	BC109C
TS73	5322 130 44154	BF199
TS74	5322 130 44154	BF199
TS75	4822 130 40963	BC559
TS76	5322 130 44154	BF199
TS251	5322 130 40408	BFW11
TS252	5322 130 44195	BF494
TS253	4822 130 40973	BC557
TS254	5322 130 44154	BF199
TS257	5322 130 44154	BF199
TS258	5322 130 44154	BF199
TS259	5322 130 44154	BF199
TS261	5322 130 44195	BF494
TS262	5322 130 40408	BFW11
TS263	5322 130 40373	BCY71
TS264	5322 130 40324	BCY70
TS266	4822 130 40964	BC549
TS267	4822 130 40964	BC549
TS268	5322 130 44154	BF199
TS269	5322 130 44154	BF199
TS271	5322 130 40144	BC109C
TS272	5322 130 40144	BC109C
TS273	5322 130 44154	BF199
TS274	5322 130 44154	BF199
TS276	5322 130 44154	BF199
TS400	4822 130 40963	BC559
TS401	4822 130 40963	BC559
TS402	5322 130 44195	BF494
TS403	5322 130 44216	BC549C
TS404	5322 130 44216	BC549C
TS406	4822 130 40964	BC549
TS408	4822 130 40963	BC559
TS501	5322 130 44195	BF494
TS502	5322 130 44195	BF494
TS503	5322 130 44216	BC549C
TS504	5322 130 44216	BC549C
TS506	4822 130 40973	BC557
TS508	4822 130 40965	BC547
TS509	5322 130 40417	BSX20
TS511	4822 130 40963	BC559
TS512	4822 130 40964	BC549
TS513	4822 130 40964	BC549
TS516	4822 130 40965	BC547
TS602	5322 130 44195	BF494
TS603	5322 130 44195	BF494
TS604	5322 130 44195	BF494
TS606	4822 130 40965	BC547
TS607	4822 130 40908	BF336
TS608	4822 130 40908	BF336
TS609	4822 130 40908	BF336

Item	Ordering number	Type/description
TS611	4822 130 40908	BF336
TS702	4822 130 40973	BC557
TS703	4822 130 40968	BSS38
TS704	5322 130 40308	BF115
TS706	5322 130 40308	BF115
TS750	5322 130 44195	BF494
TS751	5322 130 44195	BF494
TS800	5322 130 44247	BSS68
TS801	4822 130 40908	BF336
TS803	4822 130 40973	BC557
TS804	4822 130 40965	BC547
TS806	5322 130 44157	BD183
TS807	5322 130 44157	BD183
TS808	4822 130 40973	BC557
TS809	4822 130 40965	BC547
TS811	4822 130 40973	BC557
TS812	4822 130 40965	BC547
TS813	4822 130 40973	BC557
TS814	4822 130 40973	BC557
TS816	4822 130 40965	BC547
TS901	5322 130 44216	BC549C
TS902	5322 130 44195	BF494
TS903	5322 130 44195	BF494
TS904	4822 130 40964	BC549
TS906	5322 130 44216	BC549C
TS1001	5322 130 44216	BC549C
TS1002	5322 130 44195	BF494
TS1003	5322 130 44195	BF494
TS1004	4822 130 40964	BC549
TS1006	5322 130 44216	BC549C
TS1011	5322 130 44216	BC549C
TS1012	5322 130 44216	BC549C
TS1013	4822 130 40968	BSS38
TS1014	4822 130 40968	BSS38
TS1016	4822 130 40973	BC557
TS1017	5322 130 44216	BC549C
TS1018	4822 130 40968	BSS38
TS1019	4822 130 40968	BSS38
TS1021	4822 130 40963	BC559
TS1022	4822 130 40963	BC559
TS1023	4822 130 40965	BC547
TS1024	4822 130 40964	BC549
TS1026	5322 130 44216	BC549C
TS1027	5322 130 44216	BC549C
TS1028	4822 130 40963	BC559
TS1029	4822 130 40968	BSS38
TS1031	4822 130 40968	BSS38

3.6.3. PARTS LIST OF PROBE SETS

3.6.3.1. Parts of attenuator probe sets PM 9326 and PM 9327 (Fig. 3.24)

Item	*Qty*	*Ordering number*	*Description*
1	1	5322 320 10042	Probe cable 2 m for PM 9327
1	1	5322 321 20087	Probe cable 1.15 m for PM 9326
2	1	5322 321 20096	Earth lead 15 cm
3	1	5322 321 20134	Earth lead 30 cm
4	1	5322 266 20015	Measuring probe 1:1 (black)
5	1	5322 268 10029	Test pin
6	1	5322 268 10039	Test hook
7	1	5322 210 70044	Attenuator probe 1:10 (grey)
8	1	5322 264 20016	Test clip
	1	5322 111 20155	Resistor

3.6.3.2. Parts of attenuator probe sets PM 9336 and PM 9336L (Fig. 3.26)

Item	*Qty*	*Ordering code*	*Description*
1	1	5322 320 14004	Cable assembly PM 9336 (1,5 m)
1	1	5322 320 14013	Cable assembly PM 9336L (2,5 m)
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 20024	Test hook
4	1	5322 264 20028	Test hook sleeve
5	1	5322 532 60535	Protective cap
6	1	5322 256 94034	Probe holder
7	1	5322 268 14017	Probe tip
8	1	5322 321 20223	Earthing cord
9	1	5322 600 34002	Box

3.6.3.3. Parts of probe set PM 9335 (Fig. 3.28)

Item	*Qty*	*Ordering code*	*Description*
1	1	5322 264 20024	Test-hook
2	1	5322 264 20028	Test-hook sleeve
3	1	5322 268 14017	Probe tip
4	1	5322 532 60535	Protective cap
5	1	5322 321 20223	Earth lead
6	1	5322 265 94034	Probe holder
7	1	5322 320 14005	Probe assembly
	1	5322 600 34002	Box

3.6.3.4. Parts of 2 kV probe set PM 9358 (Fig. 3.29.)

Item	*Qty*	*Order number*	*Description*
1	1	5322 320 14004	Calbe assembly
2	1	5322 255 44026	Soldering terminal
3	1	5322 264 24008	Test hook
4	1	5322 264 24009	Test hook sleeve
5	1	5322 462 74001	Protective cap
6	1	5322 462 54075	Insulating cap
7	1	5322 265 94034	Probe holder
8	1	5322 264 24011	Test pin
9	1	5322 321 20223	Earthing cord
	1	5322 600 14004	Box

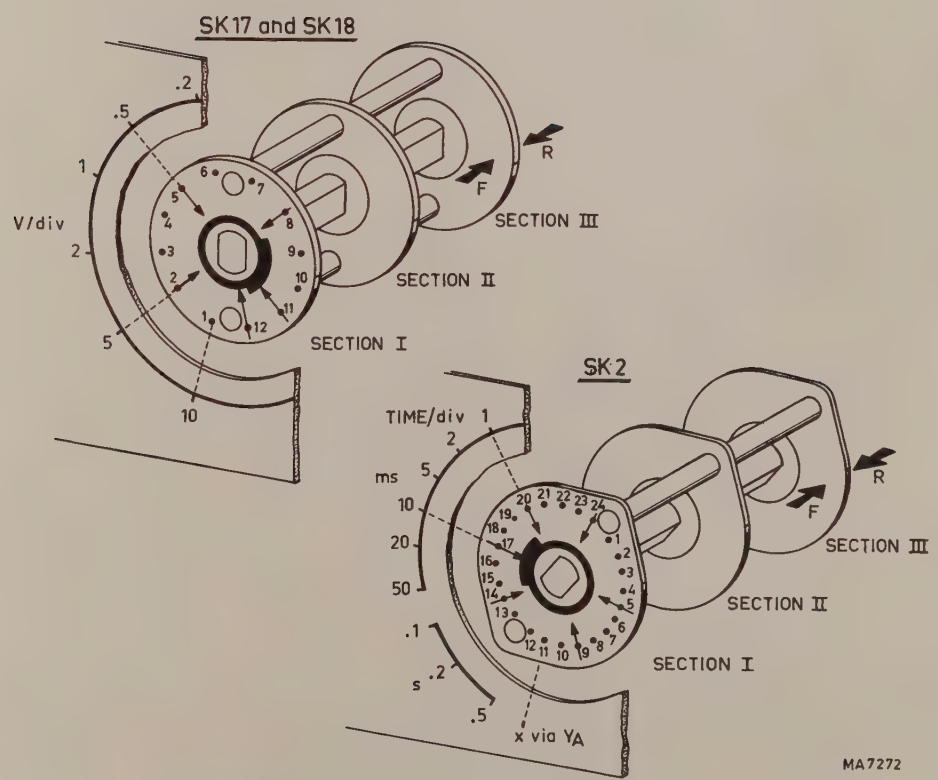


Fig. 3.43. Lay-out of the AMPL. and TIME/div switches

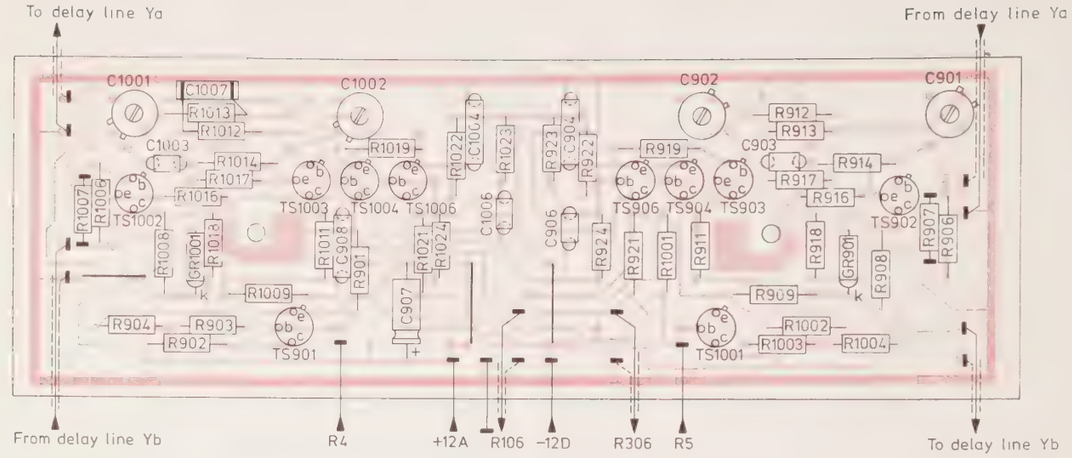


Fig. 3.44. Delay line unit

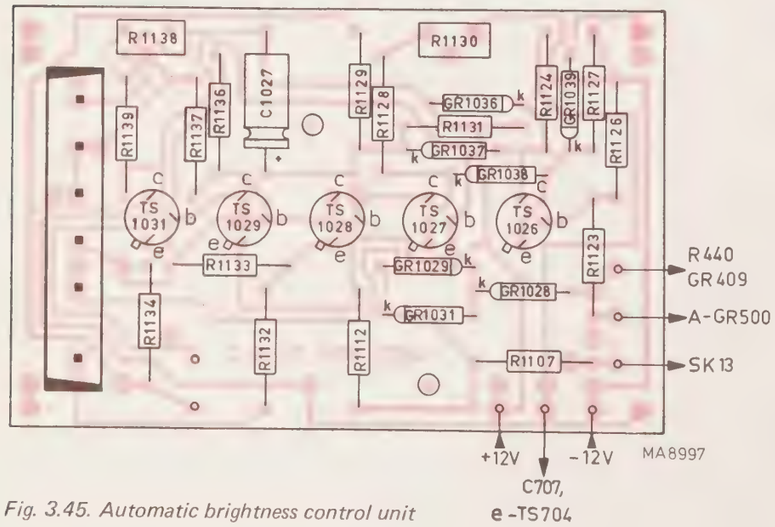


Fig. 3.45. Automatic brightness control unit

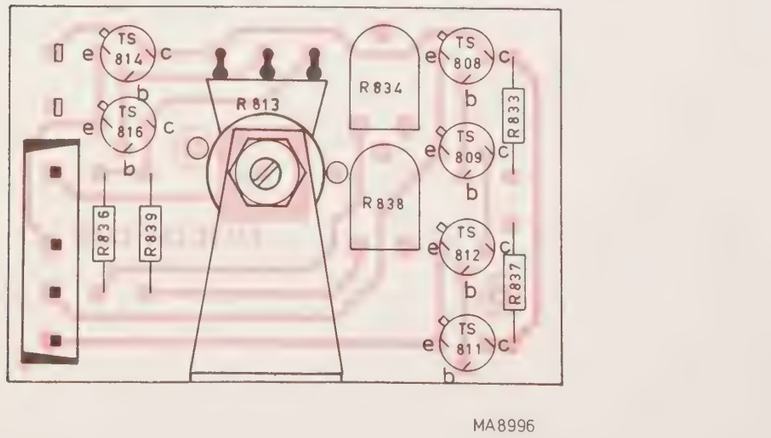


Fig. 3.46. C.R.T. adjustment unit

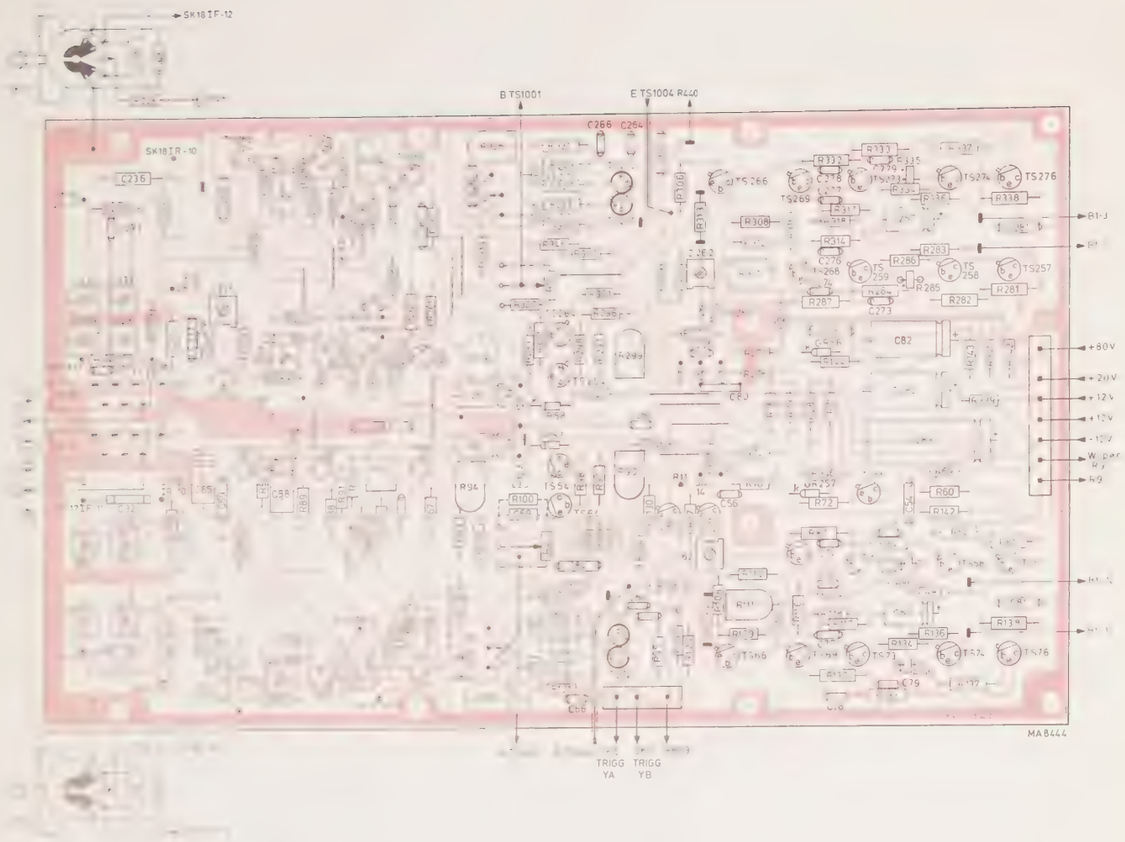


Fig. 3.47. A and B vertical amplifier unit

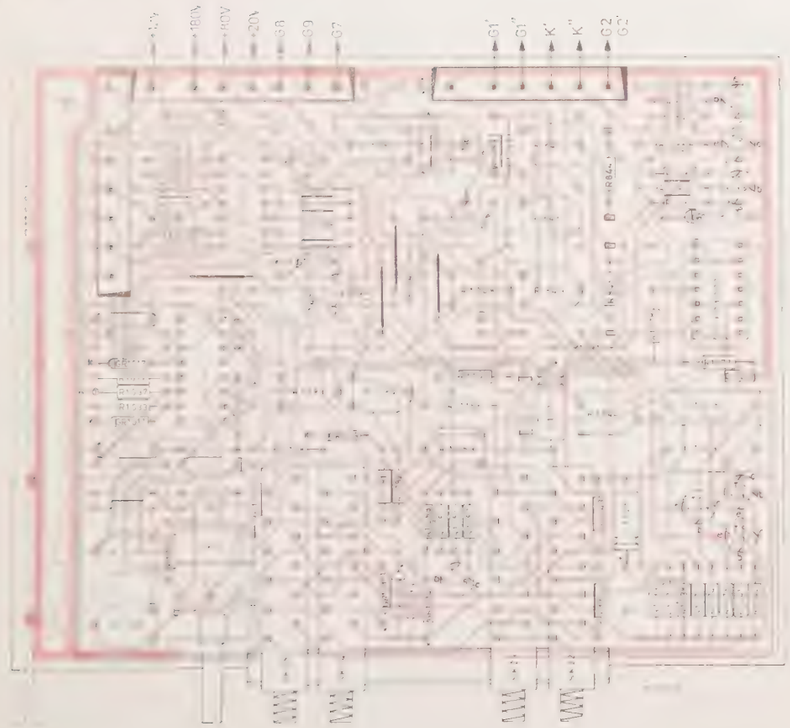


Fig. 3.48. Storage unit

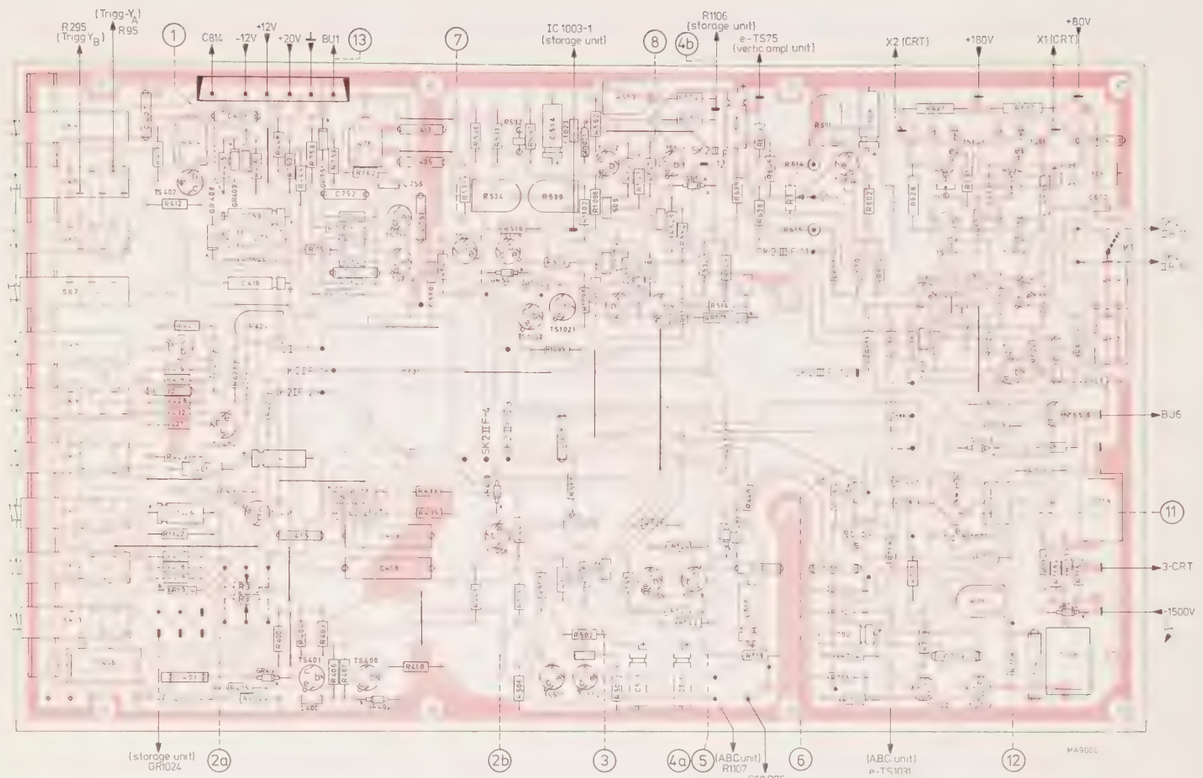


Fig. 3.49. Time-base unit

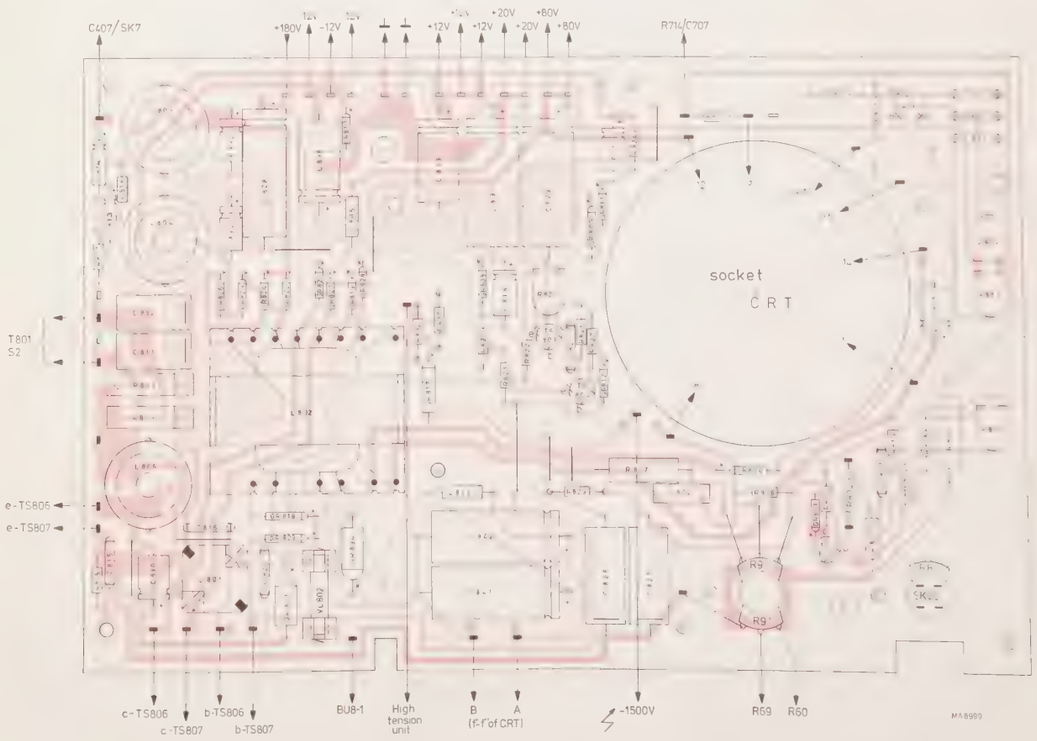


Fig. 3.50. Power supply unit

AMPL. SWITCH Y_A (SK17)

TIME/div SWITCH (SK2)

AMPL. SWITCH Y_B (SK18)

SK17 CLOSED IN POS. 7-8-9-10-11-12

SK16 CLOSED IN POS. DC AC

Y_A BU3

ATTENUATOR RESISTORS

DC BAL

V/div

FOCUS

Y_A POSITION

SK14 CLOSED FOR Y_A DISPLAY

Y_1 (C.R.T.)

Y_2 (C.R.T.)

SK18 I CLOSED IN POS. 7-8-9-10-11-12

SK15 CLOSED IN POS.

Y_B BU5

Y_B POSITION

SK15 CLOSED FOR Y_B DISPLAY

BU4

SK1 CLOSED IN POS. 1

MAINS

EXT.

DC

BU2 TRIGG

AUTO

LEVEL

MECHANICALLY INTERACTING

HOLD-OFF CAPACITORS

SK2 TR

SK2 IF CLOSED IN POS. 2-21

SK2 IF CLOSED IN POS. 1

SK2 IR CLOSED IN POS. 1

TIME/div

SK3 CAL.

TB RESISTORS

CLOSED IN POS. 1-10

X-POSITION

5-times X MAGN.

BU6 TB.OUT

MECHANICAL INTERACTING

SAVE READ ERASE WRITE

RESET

PERSIST

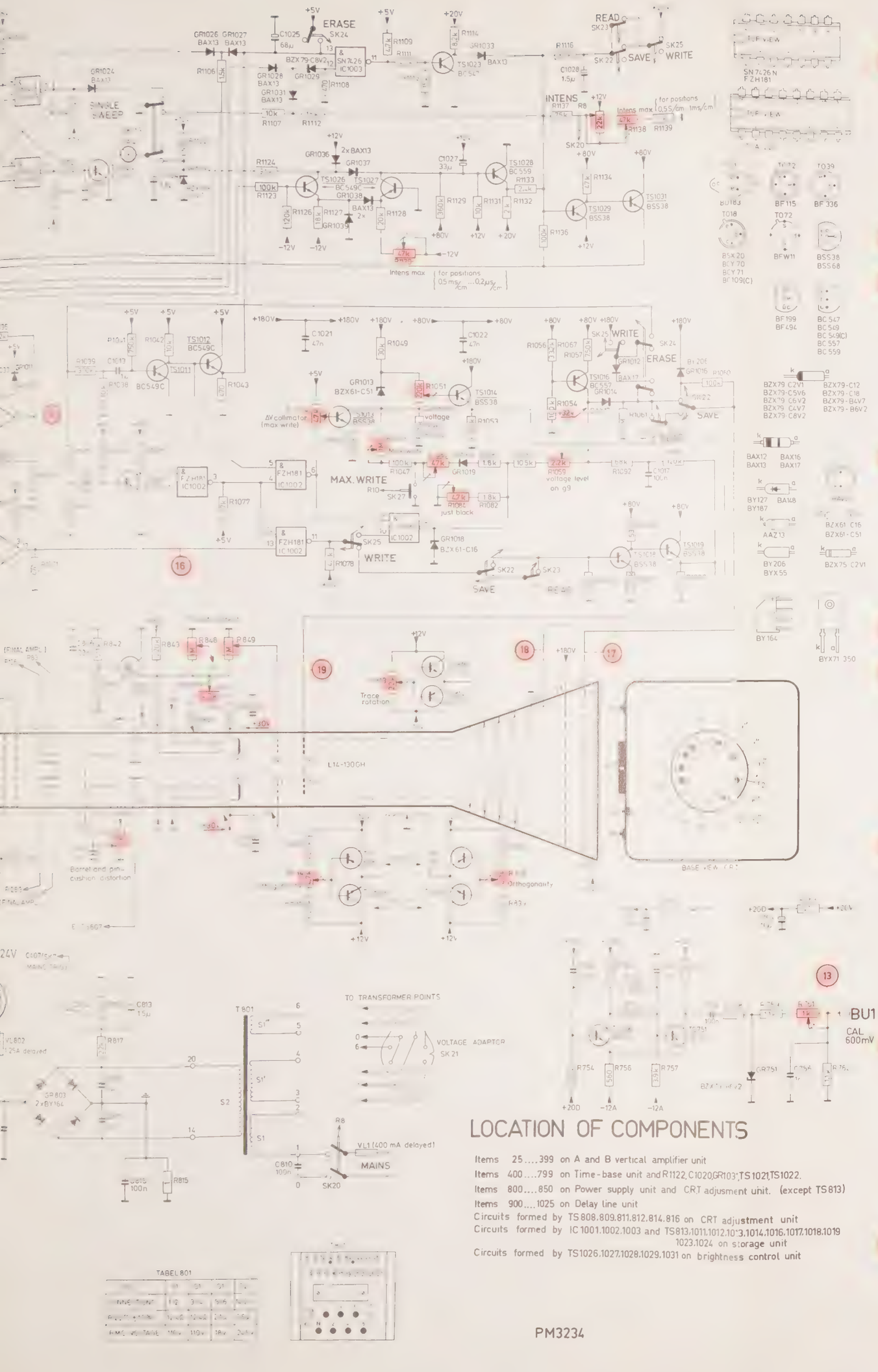
WRITE SAVE

FOCUS

EXT. DC. SUPPLY

High tension unit fourfold voltage multiplier (not short circuit proof)

BU8



LOCATION OF COMPONENTS

Items 25....399 on A and B vertical amplifier unit
Items 400....799 on Time-base unit and R1122, C1020, GR1031, TS1021, TS1022.
Items 800....850 on Power supply unit and CRT adjusment unit. (except TS813)
Items 900....1025 on Delay line unit
Circuits formed by TS808,809,811,812,814,816 on CRT adjustment unit
Circuits formed by IC1001,1002,1003 and TS813,1011,1012,1013,1014,1016,1017,1018,1019 1023,1024 on storage unit
Circuits formed by TS1026,1027,1028,1029,1031 on brightness control unit

PM3234

1 — Y=0.2 V/cm X=0.2 ms/cm
Trigger signal (sine-wave) at collector of transistor TS402
PM3234: sine-wave signal 6 Vpp 2 kHz on Y_A (1 V/cm)
Trigg via Y_A in pos + and auto. Potmeter LEVEL in the middle position
Switch SK25 (WRITE) depressed

2a — Y=2 V/cm X=0.5 ms/cm
Output signal of the long-tailed pair circuit (in this case for triggering on the positive slope of the signal)

2b — Trigger signal at the input of the trigger-pulse shaper

3 — Y=2V/cm X=0.5 ms/cm
Trigger signal at the output of the trigger-pulse shaper

4a — Y=0.5V/cm X=0.5 ms/cm
a) Trigger pulses at the input of the sweep gating multivibrator

4b — b) Hold-off signal

5 — Y=0.5V/cm X=0.5 ms/cm
Signal at the input of the sweep gating multivibrator in the absence of a trigger input signal

6 — Y=2 V/cm X=0.5 ms/cm
Driver pulses for sawtooth generator and blanking circuits

7 — Y=1V/cm X=0.5 ms/cm
Sawtooth signal

8 — Y=1V/cm X=0.5 ms/cm
Sawtooth signal at the output of cascade emitter followers circuit

9 — Y=20V/cm X=0.5 ms/cm
Time-base deflection voltage

10 — Y=20V/cm X=0.5 ms/cm
Time-base deflection voltage

11 — Y=10V/cm X=0.5 ms/cm
Blanking pulses
R8 (INTENS) fully clockwise

12 — Y=10V/cm X=0.5 ms/cm
Modulated signal of blanking pulses and oscillator signal
R8 (INTENS) fully clockwise

13 — Y=0.1V/cm X=0.2 ms/cm
Calibration signal

14 — Y=1V/cm X=0.2 ms/cm
Square wave generator (≈2 kHz)

15 — Y=1V/cm X=0.2ms/cm
Trainqular wave voltage (≈2kHz) on point 4 of IC 1001

16 — Y=1V/cm X=0.2ms/cm
R10 (Persistence) counter-clockwise
Switch SK25 (WRITE) depressed
Square wave pulses (≈2kHz) duty cycle variable

17a — Y=10V/cm X=0.2s/cm
R10 (Persistence) clockwise
Operation time of SK24 (ERASE)
Storage mesh potential (g9)

17b — Y=10V/cm X=0.2s/cm
R10 (Persistence) counter clockwise
Operation time of SK24 (ERASE)
2kHz Pulses of fig.17c
Storage mesh potential (g9)

17c — Y=10V/cm X=0.2ms/cm
R10 (Persistence) counter clockwise
Storage mesh potential (≈2kHz)

18 — Y=20V/cm X=0.2s/cm
Operation time of SK24 (ERASE)
Collimator voltage (g7)

19 — Y=10V/cm X=0.2ms/cm
SK23 (READ) depressed
SK25 (WRITE) depressed
Potential on g2-g2

MA8866

Fig. 3.51. Circuit diagram of the complete oscilloscope PM 3234

QUALITY REPORTING

CODING SYSTEM FOR FAILURE DESCRIPTION

The following information is meant for Philips service workshops only and serves as a guide for exact reporting of service repairs and maintenance routines on the workshop charts.
For full details reference is made to Information G1 (Introduction) and Information Cd 689 (Specific information for Test and Measuring Instruments).

LOCATION

□□□

Unit number
e.g. 000A or 0001 (for unit A or 1; **not 00UA or 00U1**)

or: Type number of an accessory (only if delivered with the equipment)
e.g. 9051 or 9532 (for PM 9051 or PM 9532)

or: Unknown/Not applicable
0000

COMPONENT/SEQUENCE NUMBER

□□□□□

Enter the identification **as used in the circuit diagram,** e.g.:

GR1003	Diode GR1003
TS0023	Transistor TS23
IC0101	Integrated circuit IC101
R0....	Resistor, potentiometer
C0....	Capacitor, variable capacitor
B0....	Tube, valve
LA....	Lamp
VL....	Fuse
SK....	Switch
BU....	Connector, socket, terminal
T0....	Transformer
L0....	Coil
X0....	Crystal
CB....	Circuit block
RE....	Relay
BA....	Battery
TR....	Chopper

CATEGORY

□

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

Parts not identified in the circuit diagram:

990000	Unknown/Not applicable
990001	Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002	Knob (incl. dial knob, cap, etc.)
990003	Probe (only if attached to instrument)
990004	Leads and associated plugs
990005	Holder (valve, transistor, fuse, board, etc.)
990006	Complete unit (p.w. board, h.t. unit, etc.)
990007	Accessory (only those without type number)
990008	Documentation (manual, supplement, etc.)
990009	Foreign object
990099	Miscellaneous

Sales and service all over the world

Alger: Sadetel; 41 Rue des Frères Mouloud Alger; tel. 656613–656607

Argentina: Philips Argentina S.A., Cassila Correo 3479, Buenos Aires; tel. T.E. 70, 7741 al 7749

Australia: Philips Electrical Pty Ltd., Philips House, 69-79 Clarence Street, Box 2703 G.P.O., Sydney; tel. 2.0223

België/Belgique: M.B.L.E, Philips Bedrijfsapparatuur, 80 Rue des Deux Gares, Bruxelles; tel. 02/13.76.00

Bolivia: Industrias Bolivianas Philips S.A. LA Jón postal 2964 La Paz tel. 50029

Brasil: S.A. Philips Do Brasil; Avenida Paulista 2163; P.O. Box 8681; Sao Paulo S.P.; tel 81–2161.

Burundi: Philips S.A.R.L., Avenue de Grèce, B.P. 900, Bujumbura

Canada: Philips Electronic Industries Ltd., Scientific and Electronic Equipment Division, Philips House, 116 Vanderhoof Avenue, Toronto 17 M 4G 2Jl. tel. (416)-425-5161.

Chile: Philips Chiléna S.A., Casilla 2687, Santiago de Chile; tel. 94001

Colombia: Industrias Philips de Colombia S.A., Calle 13 no. 51-03, Apartado Nacional 1505, Bogota; tel. 473640

Costa Rica: Philips de Costa Rica Ltd., Apartado Postal 4325, San José; tel. 210111

Danmark: Philips Elektronik Systemer A/S Afd. Industri & Forskning; Strandlodsvej 4 2300-København S; Tel (0127) AS 2222; telex 27045

Deutschland (Bundesrepublik): Philips Elektronik Industrie GmbH, 2000 Hamburg 73, Meiendorferstraße 205; Postfach 730 370; tel. 6797-1

Ecuador: Philips Ecuador S.A., Casilla 343, Quito; tel. 239080

Egypt: Ph. Scientific Bureau 5 Sherif Str. Cairo – A.R. Egypt P.O. Box 1807; tel. 78457-57739

Eire: Philips Electrical (Ireland) Ltd., Newstead, Clonskeagh, Dublin 14; tel. 976611

El Salvador: Philips de El Salvador, Apartado Postal 865, San Salvador; tel. 217441

España: Philips Ibérica S.A.E., Avenida de America, Apartado 2065, Madrid 17; tel 2462200

Ethiopia: Philips Ethiopia (Priv. Ltd. Co.), P.O.B. 2565; Cunningham Street, Addis Abeba; tel. 48300

Finland: Oy Philips Ab, Postboks 10255, Helsinki 10; tel. 10915

France: Philips Industrie, Division de la S.A. Philips Industrielle et Commerciale 105 Rue de Paris, 93 002 Bobigny; tel. 830-11-11

Ghana: Philips (Ghana) Ltd., P.O.B. M 14, Accra; tel. 66019

Great Britain: Pye Unicam Ltd., York Street, Cambridge; tel. (0223) 58866

Guatemala: Philips de Guatemala S.A., Apartado Postal 238, Guatemala City; tel. 64857

Hellas: Philips S.A. Hellénique, 54, Ave Syngrou, Athens; tel 230476, P.O. Box 153

Honduras: Hasbun de Honduras Apartado Postal 83, Tegucigalpa; tel. 2-9121...5

Hong kong: Philips Hong Kong Ltd., P.O.B. 2108, St. George's Building, 21st floor, Hong Kong; tel. 5-249246

India: Philips India Ltd., Shivsagar Estate, Block "A", Dr. Annie Besant Road, P.O.B. 6598, Worli, Bombay 18; tel. 370071

Indonesia: P. T. Philips Development Corporation, Jalan Proklamasi 33, P.O.B. 2287, Jakarta; tel. 51985-51986

Iran: Philips Iran Ltd., P.O.B. 1297, Teheran; tel. 662281

Iraq: Philips Iraq W.L.L. Munir Abbas Building 4th Floor; South Gate. P.O. box 5749 Baghdad; tel. 80409

Island: Heimilistaeki SF, Saetún 8, Reykjavik; tel. 24000

Islas Canarias: Philips Ibérica S.A.E., Triana 132, Las Palmas; Casilla 39-41, Santa Cruz de Tenerife

Italia: Philips S.p.A., Sezione PIT; Viale Elvezia 2, 20052 Monza; tel. (039) 361-441; telex 35290

Kenya: Philips (Kenya) Ltd., P.O.B. 30554, Nairobi; tel. 29981

Malaysia: Philips Malaya Sdn Bhd. P.O. Box 332, Kuala Lumpur;/Selangor W. Malaysia; tel. 774411

Mexico: Philips Comercial S.A. de C.V., Uruapan 7, Apdo 24-328, Mexico 7 D.F.; tel. 25-15-40

Nederland: Philips Nederland B.V., Boschdijk, Gebouw VB, Eindhoven; tel. 793333

Ned. Antillen: N.V. Philips Antillana, Postbus 523, Willemstad; tel. Curaçao 36222-35464

New Zealand: Philips Electronical Industries (N.Z.) Ltd., Professional and Industrial Division, 70-72 Kingsford Smith Street, P.O.B. 2097, Lyall Bay, Wellington; tel. 73-156

Nigeria: Philips (Nigeria) Ltd., 6 Ijora Causeway, P.O.B. 1921, Lagos; tel. 45414/7

Nippon: Nihon Philips Corporation, P.O.B. 13, World Trade Center, 32nd Floor, Tokyo 105; tel. (03) 435-5211

Norge: Norsk A.S. Philips, Postboks 5040, Oslo; tel. 463890

Österreich: Oesterreichische Philips Industrie GmbH, Abteilung Industrie Elektronik, Triesterstrasse 64, A-1101 Wien; tel. (0222) 645511/31

Pakistan: Philips Electrical Co. of Pakistan Ltd., El-Markaz, M.A. Jinnah Road, P.O.B. 7101, Karachi; tel. 70071

Paraguay: Philips del Paraguay S.A., Casilla de Correo 605, Asuncion; tel. 8045-5536-6666

Perú: Philips Peruana S.A., Apartado Postal 1841, Lima; tel. 326070

Philippines: Philips Industrial Development Inc., 2246 Pasong Tamo P.O.B. 911, Makati Rizal D-708; tel. 889453 to 889456

Portugal: Philips Portuguesa S.A.R.L., Av. Eng.° Duarte Pacheco, 6 – Lisboa – 1

Rwanda: Philips Rwanda S.A.R.L., B.P. 449, Kigali

Saoudi Arabia: A. Rajab and A. Silsilah P.O. box 203 Jeddah - Saudi Arabia; tel. 5113-5114

Schweiz-Suisse-Svizzera: Philips A.G., Binzstrasse 15, Postfach 8027, Zürich; tel. 051-442211

Singapore: Philips Singapore Private Ltd. P.O. Box 340; Toa Payoh Central Post Office; Singapore 12; tel. 538811

South Africa: South African Philips (Pty) Ltd., P.O.B. 7703, 2, Herb Street, New Doornfontein, Johannesburg; tel. 24-0531

Sverige: Svenska A.B. Philips, Fack, Lidingövägen 50, Stockholm 27: tel. 08/635000

Syria: Philips Moyen-Orient S.A. Rue Fardoss 79 Immeuble Kassas and Sadate B.P. 2442 Damas; tel. 18605-21650

Taiwan: Yung Kang Trading Co. Ltd., San Min Building, Gnd Floor, 57-1 Chung Shan N Road, 2 Section, P.O.B. 1467, Taipei; tel. 577281

Tanzania: Philips (Tanzania) Ltd., Box 20104, Dar es Salaam; tel. 29571

Thailand: Philips Thailand Ltd., 283, Silom Road, Bangkok; tel. 36980, 36984-9

Turkey: Türk Philips Ticaret A.S., Posta Kutusu 504, Beyoglu; Gümüssüyü Caddesl 78/80 Istanbul 1 Turkye

Uganda: Philips Uganda Ltd. p.o. Box 5300 Kampala; tel. 59039

Uruguay: Industrias Philips del Uruguay, Avda Uruguay 1287, Montevideo; tel 915641 Casilla de Correo 294

U.S.A.: Philips Test and Measuring Instruments Inc.; 400 Crossways Park Drive, Woodbury, N.Y. 11797; tel. (516) 921-8880

Venezuela: C.A. Philips Venezolana, Apartado Postal 1167, Caracas; tel. 360511

Zaire: Philips S.Z.R.L., B.P. 1798, Kinshasa; tel. 31887-31888-31693

Zambia: Philips Electrical Ltd., Professional Equipment Division, P.O.B. 553 Kitwe; tel. 2526/7/8; Lusaka P.O. Box 1878

750101

For information on change of address:
N.V. Philips
Test and Measuring Instruments Dept.
Eindhoven - The Netherlands

For countries not listed:
N.V. Philips PIT Export Dept.
Test and Measuring Instruments Dept.
Eindhoven - The Netherlands